DPSIR- and Stakeholder Analysis of the Use of Nanosilver

Hansen, Steffen Foss; Lindbladh, Maja K.; Schiolborg, Katrine B.; Foltmar, Mikkel

Published in:
Book of Abstracts of the S.NET 6th Annual Meeting

Publication date:
2014

Document Version
Publisher's PDF, also known as Version of record

S.NET 6th Annual Meeting
Karlsruhe 21-24 September 2014

BETTER TECHNOLOGIES WITH NO REGRET?

Book of Abstracts

(Effective September 19, 2014)

TABLE OF CONTENTS

1.1. Robotics

Chair: António Moniz

Service Robotics – Uncovering an Emerging Technology Field

Florian Kreuchauff, *Karlsruhe Institut of Technology (KIT)*
Ingrid Ott, *Karlsruhe Institute of Technology (KIT), and Kiel Institute for the World Economy (IfW)*

Service robotics is an emerging technology field that broadly speaking utilizes a high technology in order to provide services. The technology is thus at the interface between industry and service sector. However, so far it has not been part of any official statistics, on which effective policy recommendations heavily rely.
The International Federation of Robotics (IFR) has been working on a service robot definition and classification scheme since 1995. A preliminary defintion states that a service robot is a robot that performs useful tasks for humans or equipment excluding industrial automation application (compare the homepage of the IFR; www.ifr.org). Thus, the classification is done according to the intended use. Service robots can be further subdivided into those for non-commercial personal use like domestic servant robots or automated wheelchairs, and those for professional commercial services, for which they are usually run by trained operators – like fire-fighting or surgery systems in hospitals. Hence, service robots contribute to both traditional and new type services. Figure 1 outlines industrial and service robots and illustrates the operational areas.
The technology field so far is neither part of any existing official industry, patent or trademark classification system nor of any concordances not to mention national account sys- tems that allow to frame the technology field or to estimate the corresponding economic implications. This impedes a comprehensive assessment of the economic importance of service robotics with respect to employment, contribution to aggregate value creation or innovation activities.
At the same time, especially high technologies and expected future industries are in the core focus of (supra-)national innovation policies. For being effective and efficient, these policies strongly rely on credible data bases that include the entire value creation chains, starting from research and development over production and sales.
Our contribution starts at this point: we develop a lexical search query to identify service robots within patent and publication databases and thus to make the emerging technology field visible from a research point of view. We then carry out empirical analyses thereby taking several perspectives among them the mentioned sub-areas in Figure 1, global regions (USA, EU, Asia/Japan) and carry out dynamic analyses of the most important fields utilizing inter alia methods of social network analyses
.

Robots in surgery – contributions from a TA perspective

Maria João Maia, *Karlsruhe Institute of Technology (KIT), Germany*
Bettina-Johanna Krings, *Karlsruhe Institute of Technology (KIT), Germany*

In the late nineteenth century a panoply of new technology such as the x-ray or electrocardiograph emerge. These technologies, reassured patients and extended the range of medical diagnosis far beyond what the simple techniques of physical examinations permitted. Over time, medicine has become more and more technology based which structures significantly this field.
In present times, medicine is still facing new challenges with the introduction of new technologies, such as Surgical robots, considered as tele-operation systems. In fact, the recent introduction of robots in the medical sector is characterized by a technology-push approach driven by industry. Global sales of medical robots increased by 20% compared to 2011 to 1,308 units in 2012 and the most important applications are robot assisted surgery and therapy with 1,053 units sold in 2012, 6% more than in 2011. Thus, medical robots are considered the most valuable service robots with an average unit price of about US$ 1.5 million, including accessories and services.
Empirical researches show that surgical robots are spreading steadily in healthcare facilities. For these reasons, the introduction of surgery-robotics in an Operating Room (OR) show that there are changes and implications on the level of work organization, the qualification of the OR Team as well as on the level of Man-Machine interfaces. As an example, US evidences already show that the introduction of robots in anesthesiology area is substituting man- power with the introduction of "sedative robots". Furthermore, for the OR Team the introduction of robots implies a new process of learning and practice. Health institutions also have to adapt some procedures and management when it comes to dealing with surgical robots.
In relation to significant economic shifts in health sector it will be necessary to deepen the knowledge regarding the introduction of this technology in a sustainable perspective. , Here, we propose to implement Technology Assessment studies in order to introduce social and ethical aspects with regard to the overall development. To strengthen this demand empirical research from a case study will be presented.

Mind the gaps! EU and the makings of robot autonomy

Kjetil Rommetveit, *Center for the study of the sciences and humanities, Univ.of Bergen, Norway*
Kristrún Gunnarsdottir, *Lancaster University, UK*
Niels van Dijk, *Vrije University Brussels, Belgium*
Martijntje Smits, *Utrecht University, The Netherlands*

This talk explores the entanglement of visions, politics and innovation policy development with recent developments in robotics. We explore the orientations to purpose and direction with which innovations in robotics are encouraged. We explore the discrepancies between machines as reality and machines as fiction, in particular the vision of robot autonomy as fundamental to future developments with the particular aim to help solve Europe's societal problems. We argue that these complex entanglements are riddled with contradictions and 'gaps' to be minded, i.e., between industry and academic research, between technologists, ELS scholarship, policy and society at large and, last but not least, between machines of today and tomorrow. Drawing on different assessment methodologies, we argue that the political and

policy landscapes that encourages these innovation practices and cultivates imaginaries of robot autonomy is misguided (or mistaken) in its purpose-driven agenda which can only exacerbate existing contradictions. Rather, what is at stake is a level-headed politics of uncertainty to deliver a robotics agenda for a societal good that meets the criteria of responsible innovation.

R(R)I and Democratic Governance: Voices from an Unruly Public

Stevienna de Saille, *University of Sheffield, UK*

The idea of science at the service of the public has now been made explicit through the framework of Responsible (Research and) Innovation. However, R(R)I is much less clear which kinds of 'inclusive governance' will produce the desired effect of ensuring that innovation will be directed towards socially beneficial technologies, or which publics will be included and to what extent. Although there is an increasing call for the inclusion of oppositional or dissenting publics as part of R(R)I stakeholder consultations, these still tend to be understood as represented by civil society (CSOs) and non-governmental organisations (NGOs) such as Greenpeace or Friends of the Earth. In other words, 'the public' – particularly in forms of engagement which have the capacity for real influence in the governance of NEST technologies, such as citizen's juries – has traditionally been constructed as needing either to be 'clean' (meaning those who have no information and hold no prior opinion), or as represented by institutionalised entities which understand the rules of engagement, and are versed in the processes of research and presentation of technical evidence.
Overall, the result has been a systematic exclusion of the 'unclean' – or better yet, 'unruly' -- public(s) of activists, bloggers, alternative journalists, independent researchers, citizen scientists, and others who have self-educated, from most forms of opinion-gathering or consultation on NEST. But even if we agree that unruly publics deserve inclusion in a truly inclusive framework for democratic governance of controversial new technologies, how is this public to be reached and included in ways which are meaningful to their concerns? This paper draws upon ethnographic research and interviews carried out as part of the Leverhulme Trust project *Making Science Public*, during a four-day gathering on democratic control of technology organised by activists in the UK. It examines how this particular 'unruly' public understands responsible innovation, whether and how their questions differ from those asked by CSOs, policymakers, scientists and other traditional 'stakeholders', and what can be learned for R(R)I from the ways in which they envision or reject the possibility of democratic control of technological innovation. It is hoped to be a contribution to the current discussions in scientific policy-making, as well as to the academic fields of social movements, STS, and innovation studies.

1.3. Stakeholders (I)

Chair: Simon Pfersdorf

Nanotechnology Agendas: How coverage of nanotechnology shapes public opinion

Xueying Shirley Han, *Center for Nanotechnology in Society, University of California at Santa Barbara, USA*
Galen Stocking, *University of California, Santa Barbara, USA*
Richard Appelbaum, *University of California, Santa Barbara, USA*
Barbara Herr Harthorn, *University of California, Santa Barbara, USA*

Given the complex nature of many transformative technologies like nanotechnology, the public's knowledge of their potential application, risk, and policy implication is largely dependent upon media coverage. Previous studies have compared the thematic content of print and online media coverage and uncovered a divergence of content types (e.g. Cacciatore et al., 2012), which could lead to a divergence of media effects on the public depending on its media diet. This study measures these effects by applying the classical theory of agenda setting, which predicts that the media will shape the public's views of an issue, to the discussion of nanotechnology in print and online media and Twitter in the U.S. We find discussion of nanotechnology issues frequently emerging on Twitter before print media and a tighter coupling of agendas between Twitter and online media. We further characterize the role of super users, whom Runge et al. call *Nanotechnology Twitterati* in disseminating information about nanotechnology across Twitter. This shows that the environment in which discussion of Twitter occurs is shaped by multiple forces that interact through reciprocal feedback. Furthermore, this has an effect on the type of information that is propagated and the overall understanding of nanotechnology and other transformative technologies in the public. For instance, this can offer insight into how activists and scientists' communication mold the public's opinions about nanotechnology health and safety issues.

Changing roles of non-governmental organizations in the governance of nanomaterials in the occupational health and safety environment

Aline Reichow, *University of Twente, The Netherlands*
Diana M. Bowman, *University of Michigan, USA, and University of Twente, The Netherlands*

Non-governmental organizations (NGOs) appear to be largely absent in the governance debate over nanomaterials in the occupational health and safety (OHS) environment in key manufacturing jurisdictions. This paper explores the nature of NGO involvement, or lack therefore, in the nanomaterial governance debate within the United States (US) and German OHS landscape.
By drawing upon qualitative data gathered through 11 semi-structured interviews (2013-2013) in the US and Germany, in combination with a review of the literature, this paper questions

the nature of the NGO engagement process within the political landscape, and broader cultural environment. In doing so, the paper asks how we can explain the decreasing NGO involvement within the OHS nanomaterial debate? And, what does it mean for the future governance on nanomaterials health and safety within the industrial landscape? By answering these questions, the paper points to changes in the role of NGOs in the governance of new technologies in Germany and the US, and notes that critical dialogue, based on the involvement of a diverse set of stakeholders, is realized early in the development of such technologies.
The paper concludes by discussing the role of NGOs in future governance discussions on nanomaterials, and considers the role that such organizations may play in future debates around emerging technologies. Since currently media coverage of nanomaterials OHS appears to be *declining* and citizens show little concern about nanomaterials, we shall argue that the traditional role of NGOs to epitomize public outrage seems obsolete. Or, at least, in this case. Instead, it is suggested that NGOs could take an oversight role in governance activities directed at nanomaterials OHS so as to ensure the responsible development of this technology.

A Comparison of Social Science Research on Nanotechnology and Synthetic Biology

Jan Youtie, *Georgia Institute of Technology, USA*
Philip Shapira, *Manchester Institute of Innovation Research, University of Manchester, UK and Georgia Institute of Technology, USA*

Researchers in the social sciences and humanities are increasingly involved in monitoring and assessing societal aspects of emerging technologies. This type of involvement has long been a part of biotechnology, witness the ethical, legal, and social implication (ELSI) allocation of 3-5% of the Human Genome Project budget of the US National Institutes of Health beginning in the late 1980s. Although reviews of these early ELSI activities were mixed, interest in involving social science in assessment of emerging technologies continues (Fisher 2005). This research examines the involvement of social scientists in two emerging technologies: nanotechnology and synthetic biology (synbio). We seek to understand similarities and differences in how the social science community is structured around these two technologies. In particular, we are interested in the extent to which these two emerging technologies share common or dissimilar social science knowledge sources. Our data source for this analysis is comprised of 1760 articles referencing nanotechnology from 1990-2012 and 143 articles referencing synthetic biology or synbio from 2000-2012 in the Social Science Citation Index and Arts and Humanities Citation Index of Thomson Reuters' Web of Science and Scopus. These differences in timeframe are in recognition of the more recent emergence of synbio in the mid 2000s (Peccoud 2012), notwithstanding the difficulty of affixing time boundaries to the "start" of these emerging areas. The results show that social science in synbio has more of a defined emphasis on medical ethics while nanotechnology's early years had more of a visionary and science mapping orientation, which since evolved into a multidimensional base of knowledge involving governance, public perception and deliberation, science and technology studies, ethics, and evolutionary economics (Shapira et al . This finding concerning synbio reflects its extension from earlier biotechnology and human genome activity. The ability of social science researchers to embrace these other dimensions of technological emergence as they observe the development of synbio remains an open question.

Nanotechnology and Environmental Justice Movement

Tetiana Gardashuk, *H. Skovoroda Institute of Philosophy, National Academy of Sciences of Ukraine, Kyiv, Ukraine*

The original contemporary vision of social justice was presented at the work of American philosopher John Rowls entitled *A Theory of Justice* (1971). After its publications Rowls' theory of justice has been applied in many different fields of social life and decision making. Environmental policy belongs to areas in which the idea of justice plays a crucial role. Environmental protection policy has attempted to reduce environmental risk overall. However, in the process of protection of the environment, risks have been re-distributed and concentrated in particular segments of society. The unequal distribution of environmental risk is covered by the term of "environmental injustice". There are three dimensions of environmental justice vision: 1) intrageneration justice debated in the terms of a "divided planet" between poor and rich countries; 2) intergeneration justice is concerned on distribution of benefits and burdens between generations; 3) environmental justice movement as a grassroots opposition to environmental injustice. Development of the environmental justice movement makes explicit an alliance between environmentalists and social justice advocates, and between environmental values and civic rights. Originally a largely grassroots movement of local activists concerned about pollution in their neighborhoods, environmental justice now has a prominent place on the agenda of many local and regional groups and international organizations.

Development of nanotechnology adds new features to the environment justice issues and also offers many new visions to a theorization of justice. Many nanotechnologies are going to result in both environmental burdens and environmental benefits [2]. Nanotechnology development stimulates: a new level of debates on definition of the key concepts of the theory of justice ("equity", "justice", "risk" and "risk assessment', "discrimination", etc.); new visions of intrageneration and intergeneration justice. Definitions of these terms are of more than academic interest, because nanotechnology is slowly but surely insinuating itself into our societies in a highly fragmented and diffuse way [1].

The goal of this presentation is to discover how the concern about nanotechnology is incorporated in the environmental justice movement and how it reshapes the environment justice movement.

1.4. Food

Chair: Jutta Jahnel

Sector dynamics in demand articulation: Emerging sensor technologies in the drinking water and food sectors

Haico te Kulve, *University of Twente, The Netherlands*
Kornelia Konrad, *University of Twente, The Netherlands*

The drinking water and food & beverages sectors face important challenges in managing and assuring quality and safety of their products. Emerging sensor technologies enabled by micro- and nanotechnologies are expected to contribute to solving these quality and safety issues through offering innovative solutions via miniaturization, high sensitivity and specificity, and speed of measurement. While in both sectors there is a keen interest by companies in the opportunities that novel sensors may offer, both users and producers struggle with clarifying requirements regarding sensor applications and their embedding in organizational practices and sector structures.
The uncertainties users and producers face regarding requirements for novel sensor technologies is a general problem for emerging technologies. In this paper we are especially interested in how dynamics at the sector level and particular characteristics of these sectors, such as actor constellations and institutions, affect the formation and evolution of preferences and requirements. Sector dynamics appears to be important, but are yet under conceptualized and analyzed in the literature, which is more often focused on user-producer interactions. By examining sector-level dynamics we aim to contribute to literature on dynamics of emerging technologies, as well as the literature on demand articulation and user studies. To examine how demand articulation unfolds, we have conducted 30 interviews, analyzed reports on sensor developments and organized interactive workshops with stakeholders in these sectors. Sector characteristics are visible in the demand statements, for instance the widely held belief about the unreliability of sensors is reflected in articulated demands in the water sector. Our findings also indicate that dynamics at the sector level may either support or constrain articulation of requirements. For instance the competitive and fragmented value chain of food contributes to difficulties in articulating requirements regarding the application of sensor technologies. We also observe the emergence of different trajectories regarding the application of sensors and the emergence of impasses in the formulation of requirements in these trajectories, which are related to what is deemed acceptable or not in the sector. We conclude by suggesting that actors attempting to overcome impasses in specifying requirements for novel technologies should not solely focus on clarifying performance characteristics of novel options, but should anticipate early on the unfolding of trajectories and interdependencies with stakeholders in a domain regarding these novel options.

Security and Food Sovereignty and Nanotechnology: the Brazilian case

Paulo Roberto Martins, *Research Network in Nanotechnology, Society and Environment (RENANOSOMA), Brazil*

From concepts about security and food sovereignty expressed by institutions of the federal government responsible for this area under explicit We understand "Food security as a strategy or set of actions, should be intersectoral and participatory, and consists in the realization of everyone's right to regular and permanent access to quality food in sufficient quantity, without compromising access to other essential needs, based on health promoting food practices that respect cultural diversity and that are environmentally, culturally, economically and socially sustainable. Food sovereignty is crucial to ensuring food and nutrition security principle and respect the right that people have to define policies, with autonomy over what to produce, for whom and under what conditions produce . Food sovereignty means ensuring the sovereignty of farmers, gatherers, fisherman , among other groups, about their culture and about our natural resources. (http://www2.planalto.gov.br/consea/o-conselho/conceitos-1/direito-humano-a-alimentacao-adequada). We will reflect on how the development of nanotechnology is or is not contributing to Brazil to achieve food security and sovereignty. For this, we will examine whether this development of nanotechnology has contributed to: 1) Strengthening of peasant and family agriculture; 2) Diversification of production systems and their genetic basis; 3) Restructuring of the national supply systems with the strengthening of local / regional circuits of production, distribution and consumption of food in an equally diverse family background; 4) Better utilization of raw materials and energy sources available locally. The Brazilian government's actions to be analyzed are concentrated in notices / public competition conducted by MCT / CNPq and actions developed by EMBRAPA nanotechnology research unit. The path of the reflections indicated above lead us to produce some conclusions that will be presented at the end for public debate.

Beyond scientism: Towards an inclusive re-imagining of the food system

Tom Wakeford, *Coventry University, UK*

Scientism, the belief that physical science is the only source of knowledge, has been at the heart of the “food wars” between proponents of GM crops and those who support organic and other agroecological approaches. In the current stand-off, neither side is keen to enter a dialogue with the other. To move beyond this stalemate, both sides must view science as an ever-changing imaginative structure of ideas by which we try to connect, understand and interpret what we see around us. This framework allows the inclusion of non-scientistic discourses of sustainability, such as the technological trajectories envisaged by grassroots social movements. I will briefly describe recent initiatives on the development of future food systems that have embraced non-scientists knowledge in dialogue with scientists. It generated a range of fertile dialogues between different cultures and cosmo-visions that could never have emerged from a scientistic framework.

2.1. GMO

Chair: Christiane Hauser

No Technology is an Island: Envisioning & Governing the Relational Networks of GMOs

Fern Wickson, *GenØk Centre for Biosafety, Norway*

The use of biotechnology is the most controversial development in modern agriculture and remains an issue of unresolved tension around the globe.
Norway is unique internationally in that its Gene Technology Act explicitly aims to ensure that the introduction and use of genetically modified organisms (GMOs) is "socially and ethically justifiable". For this, it requires that consideration be given to how a GMO contributes to societal benefit and sustainable development. To date, no GMO has been approved for either cultivation or consumption in Norway, largely due to a failure to sufficiently address these unique requirements. This has created a desire to develop further guidance on how to operationalize the assessment of GMOs for their social and ethical justifiability.
As traditionally performed, the governance of GMOs has assessed them as individualised technological objects, distinct from the complex set of cultural concepts and socio-ecological relations they embody and engender. This sees regulators typically asking what impact a GMO will have on human health, the environment, or society, rather than asking what set of conceptual and material relations the technology represents, requires, creates and/or performs. Adopting an STS approach, the Agri/Cultures Project specifically asks: What relational networks do different agricultural systems manifest and how might these be assessed against criteria of sustainability, societal benefit and ethical justifiability?
This presentation will outline the approach of the Agri/Cultures project to envisioning the relational networks of GMOs and will discuss how these relational networks might become the subject of governance considerations, especially those of assessing sustainability and ethical justifiability that are relevant in the Norwegian cultural context. Finally the project will reflect on challenges for this task posed by the globalised and distributed nature of modern food systems and will actively seek input from the audience about the future development of this new research project and its methods.

Sharing moral responsibility for hazards of GMOs

Zoë Robaey, *Department of Values, Technology and Innovation, Faculty of Technology, Policy and Management, Delft University of Technology, The Netherlands*

In this paper, I seek to develop a framework for sharing moral responsibility for preventing hazards of GMOs. Regulations ascribe duties regarding risks to actor groups involved in the development and use of GMOs in agriculture. However, hazards also encompass uncertainties and ignorance, for which the ascription of moral responsibility remains unclear. The argument

that responsibility ascription for risks is an important factor for technology acceptance should be extended to responsibility for hazards. Indeed, the debate around uncertainties of GMOs has been one of the major limiting factors for the use of GMOs. In order to define a framework for shared moral responsibility for preventing hazards, I identify the actors that will share this moral responsibility. Drawing from the role of moral responsibility in ownership, I distinguish between moral responsibility for owners and non-owners of GMOs. I also argue that owners have a special moral responsibility since they are the ones purposely carrying out an action with a technology. Moreover, regardless of the extent of ownership, I argue that all owners share moral responsibility to prevent hazards of GMOs to the same extent. However, for the purpose of effectiveness, I argue that responsibility should be ascribed according to capacities to carry out certain tasks as well as their roles. I also look at the capacities and roles of non-owner actors to establish their responsibility. Such a suggestion implies that ownership might be given over GMOs for the purpose of preventing hazards, which would, in turn, suggest changes in the governance of GMOs and have implications for responsible research and innovation.

National mobilization is the major lever: measuring the anti-GM movement's degree of Europeanization

Franz Seifert, *University of Vienna, Austria*

The anti-GM movement is the most powerful anti-technology movement in recent years and it scored its biggest success in the European Union, where agro-food biotechnology is virtually banned from consumer markets and GM authorization processes and food labelling regulation are the strictest in the world. How did the anti-GM movement help to bring about these changes? Did it directly address EU institutions and decision-makers? Did it specifically bank on transnational networks and organisations to gain access to the EU's characteristic multi-level decision making processes? Or did it rely on national publics and governments to push for change at the European level? I present the results of a quantitative analysis designed to measure the degree of the anti-GM movement's 'Europeanization'. The data cover the movement's evolution over fifteen years in both five EU member countries–Austria, France, Germany, Spain and the United Kingdom (N=1741)–and at the supranational, i.e., European, and international level (N=112). The analysis clearly shows that 'domestication'–i.e., staging of protest events in national arenas with the objective of influencing EU decision-making via national governments as intermediaries–constitutes the by far most important action strategy. As a result, national anti-GM campaigns retain their specific appearance and idiosyncracies, while transnational harmonization of national controversies is comparatively insignificant. Nevertheless, transnational movement organisation and action repertoires both beyond and within national arenas exist and fulfil specific functions, mostly as coordination and information. Their closer inspection highlights constraints and potentials of 'Europeanized' movement action against a technology mired in controversy.

2.2. Nano: International Perspectives

Chair: Laura Cabrera

Dynamics and innovation practices for new technologies Responsible (Research and Innovation) Publics and their relations to newly emerging sciences and technologies Governance of Nanotechnology – researching, protecting, communicating

Astrid Epp, *Bundesinstitut für Risikobewertung (BfR), Berlin, Germany*
Mark Lohmann, *Bundesinstitut für Risikobewertung (BfR), Berlin, Germany*
Gaby-Fleur Böl, *Bundesinstitut für Risikobewertung (BfR), Berlin, Germany*

Nanotechnology has to be considered as a key enabling technology. But even so, the development of nanotechnology and especially the development of so-called nano-products is accompanied by still unsolved questions concerning the safety of nanotechnology and its applications. This is even more important, the more nanotechnology and its applications will penetrate various social realms. It will change - and partially *has* changed already - workplaces, consumer goods, medical treatment, production processes, to name only a few. As with all new technologies, there is both a knowledge base of new insights and experience as well as a large amount of uncertain knowledge. Assessment of the consequences of new technologies is therefore of key importance when societies open the door to new technical challenges.
The Federal Institute for Risk Assessment (BfR) is responsible for the scientific assessment of risks in the realm of health consumer protection as well as it has the remit for risk communication. Thus, it has to communicate the results of its assessments in a transparent and understandable manner to its various stakeholders. Regarding Nanotechnology, BfR in a very early stage of the development of the technology issued population surveys and media analyses in order to observe the public's perception of nanotechnology and align its communication strategy with existing information needs. At the same time, as early as 2007, BfR, the Federal Institute for Occupational Safety and Health (BAuA), the Federal Institute for Risk Assessment (BfR) and the Federal Environment Agency (UBA) developed a research strategy in order to be able to answer any open questions relating to nanomaterials and weigh up their opportunities and risks. By so doing, it synchronised research, risk assessment and risk communication on nanotechnologies.
Against this background, the talk will outline the various activities that have been unfolded at government level, aiming at a socially responsible development of nanotechnology. It will present the current results of a representative population survey carried out in 2012 and from a media analysis for the years 2008-2013. Additionally, the first assessment of the joint research strategy will be presented, for which the state of over 80 research projects on the opportunities and risk aspects of nanotechnology was scrutinised in great detail. By so doing, the strategy of governmental agencies will be outlined that aims at the responsible development and implementation of a new technology and that, at the same time, can also be understood as a reaction to less successful introductions of new technologies (e.g. the implementation of genetic engineering in Germany).

Practicing Responsible Innovation in NanoNextNL

Bart Walhout, *University of Twente, The Netherlands*

Responsible (Research and) Innovation is put forward as an integrative concept, tapping into a spirit of anticipation, responsiveness and care, and pulling together various and diverse normative orientations for research and innovation. This ambition raises the question how the governance of responsible innovation might look like and under what conditions governance strategies can be effective. In this paper lessons will be drawn from the *de facto* governance of responsible innovation in NanoNextNL, a national research and innovation program in micro and nanotechnology in the Netherlands.
The research heuristic for learning from *de facto* governance has been developed in the FP7 project Res-AGorA. (See www.res-agora.eu) Following this approach the dynamics of governance processes are analysed as emerging from the dynamic interplay between (mostly organized) actors, the governance arrangements they draw on and the governance practices in which they work towards legitimate objectives and outcomes (cf. Kuhlmann 2001, Benz 2006, Braun 2006). The *de facto* dynamics and outcomes are not only shaped in relation to top-down strategies, but also to co-existing modes and styles of governance, which can have added up to certain patterns (cf. Rip 2010). In fact, many, if not all normative orientations under the banner of responsible innovation are not new and already institutionalised in manifold governance arrangements.
NanoNetxNL provides an interesting case in this respect as it has been funded under the condition of compliance to the European Code of Conduct for Responsible Nanosciences and Nanotechnologies Research. However, in the establishment of NanoNextNL the notion of responsible development had already figured in the inclusion of a Risk Analysis and Technology Assessment (RATA) track in the research agenda. While the idea of parallel research is not new, the ambition for RATA has, spurred by a national public dialogue on nanotechnology, been set to integrate RATA throughout all projects in NanoNextNL.
Drawing on (participatory) observation, interviews and document analysis the paper traces how the framing of responsible innovation tends to be narrowed down to safety issues in relation to the *de facto* governance practices in which the (integration of) RATA is being discussed. However, new efforts have been initiated, stimulating reflection and informal interaction among target groups in NanoNextNL.

The societal incubator for emerging nanotechnologies, a next step for Constructive TA?

Harro van Lente, *International Centre for Integrated assessment and Sustainable development (ICIS), Maastricht University, The Netherlands*

In this paper I introduce and corroborate the notion of 'societal incubator' as a means to improve the assessment and co-design of emerging nanotechnologies. The development of applications of nanotechnologies is widely stimulated, based on the promises of societal contributions. Yet, it is also characterized by technical, commercial and regulatory uncertainties, which give rise to 'waiting games, or paralyzing dependencies between researchers firms, public authorities, NGOs and parliaments (Parandian, Rip and Te Kulve, 2012).
The notion of 'societal incubator' builds on the well-established practice of 'business incubator', where promising research is helped to develop into a (small) business. Business incubators have been designed to support spin-off initiatives from university research. They

are given resources, such as specialized knowledge, access to capital, office space, etcetera. This results in a protected space, which allows trial-and-error. Moreover, coaching is provided to guide the entrepreneur and the development of his or her business. Business incubators can be understood as a solution to a particular 'waiting game': investors are willing to invest, but do not know in what, the researcher/entrepreneur is willing to set up a business, but waiting for capital to start.
Likewise a societal incubator could act as a solution to broader waiting games. Here the aim is not to develop a specific product or a specific business, but to create a space to assess and develop a range of applications, products and businesses. Waiting games in this broader sense often relate to indecisive regulation, investment uncertainties, and the fear of adverse public ideas. The idea of a societal incubator is to provide (i) resources, (ii) a protected space (iii) collective coaching. Examples of these aspects are drawn from cases of nano-encapsulation in food, lab-on-a-chip and applications in manufacturing.
I will argue that the societal incubator can be seen as a next step for Constructive Technology Assessment (CTA), which thus far had been limited to mapping the dynamics and to co-designing technologies, and has less contributed to actual societal embedding.

Nanotechnology for whom? The Technological Funds and development of nanotechnologies in Argentina

Tomás Javier Carrozza, *Mar del Plata National University (UNMdP), School of Agricultural Sciences, Balcarce, Argentina*
Susana Silvia Brieva, *Mar del Plata National University (UNMdP), School of Agricultural Sciences, Balcarce, Argentina*

[to be confirmed]

Since mid-2000´s, the nanoscience and nanotechnologies (N&N) have a central a place in discussions about global development. With the biotechnology and the Information and Communication technologies (ICT) are part of the convergent technologies (CT). CT are being used in sectors like agrifood, energy, environment, electronics, telecommunications and are occupying an increasingly important place in the public and private sector R&D agendas. In Latin America, this process has a huge impact. Under the belief that they could allow an improvement of the competitiveness at the international level, central governments have been allocating increasing resources in R&D nanotechnology agenda. As a consequence, they launched initiatives that place nanotechnologies in a central place on the nation's development programs.
In Argentina, nanotechnologies are a key sector of the C&T strategic plan for 2012-2015 together with ICT´s and biotechnologies. From institutions such as the Ministry of science, technology and innovation (MINCyT) they try to fund R&D research projects. On the other hand, with institutions as the Argentinean Nanotechnology Foundation (FAN) and policy instruments such as the technological funds (FONARSEC and FONTAR) they try to generate products and process to generate R&D dynamics.
The TF are administered by the National Agency for Scientific and Technological Promotion (ANPCyT) and are one of the main instruments for financing R & D projects at the public level. Under these, N & N was a priority area, together with biotechnology, ICT, Energy, Health , Agribusiness, Social Development, Environment and Climate Change.
While the use of TF for the generation of dynamic R & D has been growing year after year and now have a leading role among the policy instruments of STI , the analysis of the working

of this instrument are scarce, raising questions about their internal dynamics, as well as on the implementation of the results initially planned.
In this context the aim of this paper is to analyze, taking as starting point the call for the specific sectorial fund (FONARSEC) for N & N projects, the operation of the TF trying to understand the relationship between the objectives set by them, the knowledge generated and their use in solving national problems. Also seeks to begin to understand the conceptualizations about the use of the TF and the N & N in the generation of R & D dynamics in Argentina.

2.3. Stakeholders (II)

Chair: José Maria Albuquerque

Reflections on a Levinasian Concept of Stakeholder Engagement and Participation in Industrial Responsible Innovation Processes

Vincent Blok, *School of Social Sciences, Wageningen University, The Netherlands*

In the context of Responsible Innovation (RI), stakeholder engagement, participation and partnership are seen as important prerequisites for responsible business practices. Commitment to partnerships with stakeholders like NGO's does not only enhance the wealth-creating capacity of a company (Post *et al.*, 2002; Harrison *et al.*, 2010)), avoid negative outcomes of business processes and promote an excellent company reputation (Graven & Waddock, 1994; Fisher & Reuber, 2007). It should primarily enhance more responsible or ethical business practices (Wood, 2002). Especially in case the inequality among stakeholders is potentially enhanced by business practices, or in case of uncertainty with regard to the future impact of new products and services, participation and partnership are required; in order to improve ethical decision making processes and increase democratic participation in these decision processes, stakeholders who are possibly affected by these business practices are involved (Belucci *et al.*, 2002).
Because many stakeholders have differing ideas about what exactly is a 'responsible' action in business and innovation, the participation and partnership in business practices could be limited. These differences among stakeholders are nog only due to their different assessment of the *content* of RRI; the problem definition of 'climate change' and its solution in the business context will be framed differently by different stakeholders for instance. Furthermore, some actors are more powerful than others in defining the problem and its solution. It is expected that power imbalances are especially at stake in case of ethical issues in business and innovation, exactly because of the different value frames of the different stakeholders (cf. Bryson *et al.* 2006). Finally, differences among stakeholders are due to different agenda's and divergent motives for profit and non-profit organizations for instance (Yaziji *et al.*, 2009).
Because participation and partnership can be limited by fundamental power-, vision-, goal-, sector- and motive-deviations among stakeholders (Blok & Lemmens, 2014; Holmes & Smart 2009), the literature focuses on the initial conditions affecting partnership formation and the ways stakeholders try to overcome these differences and align partners in order to enhance successful participation and partnership. Recent research is focussing for instance on models of business involvement in general (Reed *et al.* 2009) and value frame fusion in particular (Le Ber *et al.* 2010). With this, the literature on participation and partnership show a tendency towards convergence, consonance or complementarity among stakeholders (Blok 2014). Because the ideals of partnership and participation are difficult to realize in practice (Hansen, 2006), we reflect on a concept of participation and partnerships which is able to take the fundamental differences among stakeholders into account in this paper. The philosophy of Emmanuel Levinas can help us to conceive such a concept of participation and partnership, in which the *otherness* of partners is not reduced in order to achieve alignment and harmony

among stakeholders. For Levinas, the relation with the other is characterized by radical alterity. The other stand before me and is irreducible, but this doesn't mean that I do not have a relation with him (Lim, 2007). The irreducible other calls for our response to him in a non-reductive way, i.e. calls for our embracing of the other while leaving him intact at the same time. According to Levinas, precisely this effort is called *participation* (Levinas, 1969). In this paper, we reflect on this concept of participation or 'relationless relation' with the other, which enables us to conceptualize the limitations of stakeholder engagement, participation and partnerships in responsible innovation processes in a positive way.
In section one, we will first identify several challenges with regard to stakeholder engagement and the limitations of stakeholder participation in industrial responsible innovation processes. Based on Levinas' concept of participation as relationless relation, we will develop a Levinasian concept of stakeholder engagement and partnership in section two. In section three, we apply our Levinasian concept of stakeholder engagement on the identified challenges and limitations of stakeholder participation in responsible innovation practices. With this, we open a new perspective on the opportunities and limitations of stakeholder engagement in the context responsible innovation (RI), and provide new directions for managing these partnerships.

The legitimacy of transnational private governance arrangements. Learning from the international nanotechnology process

Evisa Kica, *University of Twente, The Netherlands*

In technology regulation research, legitimacy issues have been raised by few scholars only. The limited body of literature includes normative accounts of legitimacy, but also a couple of empirical studies on the legitimacy of the European and international health and safety regulation, and transnational standardization bodies. Although these accounts offer valuable insights with regards to transnational legitimacy debates, the concepts of legitimacy they propose are often too narrow. In these studies it is still unclear how legitimacy of transnational private governance arrangements (TPGAs) related to technology regulation can be conceptualized and evaluated in practice. Or how can the perceptions of stakeholders with regards to the legitimacy of TPGAs be assessed empirically? Under which conditions can these governance arrangements ensure legitimacy?
This paper aims to provide first answers to these questions. It develops an analytical framework that serves to understand the legitimacy of TPGAs related to technology regulation in practice. This framework is linked to the various theoretical studies of legitimacy and aims to complement the current stream of research on transnational legitimacy. More specifically, we follow two major steps to develop the analytical framework: a) first, we bring together the procedural and substantive norms of legitimacy which guide TPGAs and provide the basis for their legitimacy, and b) second, we define how the legitimacy of governance arrangements related to transnational technology regulation can be measured in practice while reconceptualizing the influential distinction between input, throughput and output legitimacy.
In the paper, this framework is tested with a survey amongst key actors who are involved in the development of international nanotechnology standards. ISO Technical Committee on Nanotechnology (ISO/TC229) is our case study. In particular, we reflect on the perceptions of the key stakeholders to understand the extent to which they feel that the legitimacy norms that guide the functioning of TPGAs are effectively taken up in practice at the ISO/TC229. Furthermore, we explore whether the characteristics of stakeholder groups (such as the

country of origin, type of the organization, size of the organization, technical expertise and attendance of the TC229 biannual meetings) impact their perceptions on the legitimacy of TC229. A total of 77 survey responses are analysed for this purpose. The case study serves to indicate the value of the framework for analyzing the legitimacy of transnational technology regulation in practice, as well as to provide insights into how key actors prioritize norms of legitimacy in regulatory processes.

Reflecting on the close collaboration with policy practitioners in developing a model of public engagement with science, technology and innovation (STI) policy in Japan

Mitsuru Kudo, *Kyoto University, Japan*

We have been developing a model of public engagement with science, technology and innovation to feed diverse public voices into the actual policy. Our working model places a strong emphasis on close collaboration with policy practitioners such as government officials and civil servants, who are interested in incorporating public dialogues into the existing policymaking process around STI. We have so far worked with a few policy practitioners on several STI policy topics including the national government's initiative entitled the "Japan Vision 2020", which was to be utilised in backcasting approach for policymaking in STI-related policy areas and beyond. For this initiative, our project firstly ran a series of dialogue events to engage with members of the public to explore their views about the future of the Japanese society in 2020. We then linked the public views identified in those dialogue events to the data of science and technology foresight published by the National Institute of Science and Technology Policy, to produce a draft of the "Japan Vision 2020". The draft was polished and finalised jointly by our project members and the collaborating policy practitioners, and was finally presented to the government. The government later published an official document of the finalised "Japan Vision 2020", in which we could identify a number of the views about the Japanese society in 2020 expressed by members of the public in our dialogue events. This indicates that our project's primary objective, namely feeding the public voices into the actual policy, was achieved to a degree. Through this experience of working closely with policy practitioners on the Japan Vision 2020, however, we also came to see several problems with our working model of public engagement, both at the practical and conceptual levels, that would make the public engagement practice rather instrumental than democratic. In this paper, I will present an overview of the project and its working model of public engagement, review its application to the "Japan Vision 2020", and then discuss the model's strengths and limitations.

.

2.4. Intersections and Divergences: Sustainibility, Responsible Innovation and Intervention Research

Chair: Rider Foley

Abstract of the session: The frontiers of knowledge generation and innovative technologies offer promising solutions to the challenges facing humankind and the planet. Despite this promise, as the conference's subtitle asks: can we create *Better Technologies with No Regret*? A plethora of cases demonstrate that technological progress and the control and manipulation of knowledge can create negative outcomes that outweigh recognized gains. To mitigate these potential negative consequences, a variety of normative principles and governance processes have been proposed by sustainability science researchers and responsible innovation scholars, respectively. The concept of sustainability was born out of a response to environmental degradation and evolved into normative goals that offer a means to guide the just, equitable, and safe—for humans and the environment—design of technology. In parallel, responsible innovation, with roots in technology assessment, has emerged as a response to the unforeseen, negative outcomes of the technological innovation process. The normative goals from sustainability and instructive processes from responsible innovation beg the question of how to transition from current practices toward desired outcomes. Intervention research offers one possible answer. Intervention research transforms the social studies of science scholar from a 'neutral observer' into an 'engaged researcher' who intervenes in knowledge generation and technological innovation processes. The intersections and divergences among sustainability, responsible innovation, and intervention research are, largely, unexplored. This panel will pull-apart and re-combine the concepts of sustainability, responsible innovation, and intervention research. First, Michael Bernstein will speak to sustainability and intervention research, second, Colette Bos will handle responsible innovation and sustainability, and, finally, Lauren Withycombe Keeler will discuss contributions of future studies to sustainability and responsible innovation. Rider Foley will moderate a plenary discussion.

3.1. Conceptualising RRI

Chair: Arie Rip

Exploring "Responsibility" in Research and Innovation from a European Perspective

Stephan Lingner, *Europäische Akademie Bad Neuenahr-Ahrweiler GmbH, Germany*

The social value of innovation from new or emerging technologies cannot be taken for granted neither from the perspective of the supply side nor from the demand side. Nevertheless, actors, stakeholders and – regarding sunk public funds for research – even not directly concerned people should have a common interest in those innovation processes, which develop within frameworks, which could be outlined as "responsible".
Responsible research and innovation – although a pending goal – quite recently became a key notion and claim of innovation policies and research funding in Europe. The question arises if research and innovation were not responsible before. Recall, that long ago other concepts like technology assessment have already established mature and effective procedures for critical reflection on new technologies and on related policy advice. Critics might be suspicious, that old wine might be now served in new, fashionable bottles. Anyway, the notion of responsibility seems to be too ambiguous and vague to give orientation for technology governance – at least from a brief look.
Should we therefore leave this concept or should we try to get some flesh on the bare bones of responsibility in the context of "better technologies with no regret"? The latter seems to be worth trying. There are some theoretical but also certain practical considerations from the European policy context, which might help to specify and discuss the still vague concept of responsibility in more detail and with respect to different reflective dimensions. These considerations will be illustrated by selected emerging technologies, where appropriate.

Whence RRI? Whither RRI?

Tsjalling Swierstra, *Maastricht University, the Netherlands*

In only a few years time, the concept of RRI has managed to attract quite some attention. This success is striking, because the concept seems to imply that previously R&I were less than responsible. I doubt that many technology and policy actors now embracing RRI are willing to concede this point. In my presentation I want to reflect on the conditions under which a concept like RRI could come to the fore. Not only will this help us to determine some of the concept's strengths and weaknesses, but it will also help us to identify some of the challenges ahead. I will review five such conditions:

1. the financial crisis, which increased the relevance of public funding for R&I;
2. the increasing success of technology's victims to make themselves heard;
3. the rise of postnormal science and technology (Funtowicz & Ravetz 1993);
4. an ever increasing entanglement of technologies and the life world; -> leads to more *ambiguity* [examples intimate technology]

5. and – last but not least - the ‘practice turn’ in the study of science, technology and society.

I will argue that these conditions not only ensure that RRI is not a passing fad, but also necessitate a paradigm shift in how we think about taking up that responsibility. Corresponding to these five developments, I will distinguish five dimensions of responsibility: aspirational , democratic , collaborative, comprehensive, and dynamic responsibility.

How can responsibilisation be enhanced in Responsible Research and Innovation governance?

Bärbel Dorbeck-Jung, *Universitity of Twente, The Netherlands*

Responsible research and innovation (RRI) is becoming a hype. There is a host of RRI projects and a new journal on responsible innovation has been launched very recently. The RRI movement seems to be inspired by a new élan to understand how a fitting sense of responsibility can be distributed across innovations and the complex systems in which they are embedded (Guston et al. 2014,1). RRI research is interdisciplinary. STS scholars are collaborating with philosophers, ethicists, social scientists and legal scholars to get insights into how a new sense of responsibility can be conceptualized and incorporated in innovation practices.
This paper focuses on regulatory governance of RRI. To guide RRI a host of regulatory tools exists. Regulatory tools include soft instruments like codes of conducts, benchmarks and standards, but also legislation like clinical trials and good laboratory practices regulation. For the success of RRI the workings of these regulatory tools are essential. This paper explores conditions under which RRI regulatory tools are productive in practice. The paper assumes that ‘productivity’ is enhanced by a responsibilisation process that stimulates or presses actors to take the responsibilities seriously that are distributed by RRI regulation. Regulatory governance research shows that the motivation of the involved actors is crucial for responsibilisation. This is why the paper focuses on the conditions that exert influence on the actors’ motivation. The aim is to provide lessons on factors that encourage the willingness to use RRI regulatory tools. In a first step the paper deals with the notions of responsibilisation and productivity of RRI regulatory tools. Second, motivational factors s are discussed and illustrated with productive and unproductive examples of RRI regulation. This leads to conclusions on how responsibilisation can be enhanced in RRI governance.
The paper builds on research of the project ResAgora which aims at developing a meta-governance framework for RRI.

3.2. RRI Perspectives

Chair: Torsten Fleischer

The SoRoSol-Case: Boundary objects as ways, means, and ends in integrated research?

Heidrun Åm, *Centre for Technology and Society, Department of Interdisciplinary Studies of Culture, NTNU, Norway*
Knut H. Sørensen, *Centre for Technology and Society, Department of Interdisciplinary Studies of Culture, NTNU, Norway*

In recent years, science policy has increasingly striven for responsible innovation and enhanced public deliberation related to techno-scientific developments. In the course of these efforts, the Norwegian Research Council funded four Integrated Research (IR) projects that are marked by close collaborations between former separate research communities, such as—in the case of our project Socially Robust Solar Cells (SoRoSol)—material sciences, industrial economy, science and technology studies (STS) and philosophy. This paper reports from our experience with this IR project.
SoRoSol (funded by the Norwegian nanotechnology program) aimed at building a platform for socially robust development of new high efficient solar cell technologies. According to its mandate, the interaction between the interdisciplinary team was supposed to trigger learning and to change attitudes of the team members. This concerned—according to the project description—primarily the choice of materials. The material scientists on board aimed at developing new materials for solar cells, and *how they selected candidates for new materials* should be influenced by considerations brought forward in the interdisciplinary project team. In this presentation, I will present our experiences with different methodologies that we tried in the course of our work. I will reflect on questions such as how productive the embedding of social scientists in laboratories is, in relation to, for example, opening up the laboratory by dialogue meetings. Another important topic will be how to establish mutual understanding and good communication in interdisciplinary projects. Current conceptions of this problem in IR (Fisher 2006, Schuurbiers 2011) seem to address this issue rather one-sidedly by suggesting that the ELSA scientists have as their task so-to-speak to go native and become familiar with the project partners' epistemology, problems, research methods and tools. But are there other strategies to facilitate interdisciplinary communication besides the demanding development of what Collins and Evan (2003) called *interactional expertise*?
An interesting candidate is the development of *boundary objects* to reach cross-disciplinary communication. They can have several functions. Boundary objects can serve as analytical concepts (*ways*) for categorizing the results from the input of comprehensive engagement activities. In addition, they can be *means* to talk about solar cell development in an interdisciplinary setting. Furthermore, they can indicate *to what ends* we conduct IR. As I will show with our case, the boundary objects, that crystallized in diverse engagement settings, were indeed formulations of potential obligatory passage points (Callon 1986) new materials might have to pass in order to successfully translate into innovative solar cells.

Epigenetics: Science of Change – Signs of Change?

Stefanie B. Seitz, *KIT, Institute for Technology Assessment and Systems Analysis (ITAS), Germany*

Within the past decade(s), epigenetic has emerged as a branch of molecular genetics and is currently experiencing a real hype. In modern epigenetics scientists from various fields are united in their search for the environmental mechanisms that influence gene expression in the long term and even transgenerationally. The fundamental finding that an altered phenotype can be inherited without alterations in the corresponding gene sequence – which even brought old Lamarck back into the game – prompted some authors to call epigenetics the "Science of Change". Although it is completely unclear at the moment what falls under "epigenetics" and what not – it is safe to say that epigenetics is perceived as revolutionary in life sciences. But what do the findings in epigenetics mean for society? Will they also lead to new ways of thinking and shifts in values?
Epigenetic research, despite being still in its infancy, increasingly provides valuable information for applications in basic molecular research (e.g. RNAi), but also in diagnostics and therapy. In addition, epigenetic knowledge becomes more and more relevant for fields beyond research and the clinic. This paper aims to frame epigenetics under the concept of "new and emerging science and technologies" (NEST) and gives an insight into the promises and visions as well as already existing applications of epigenetic knowledge. Moreover, it addresses societal implications on the horizon. Therefore, first insights into public perceptions will be given by presenting the results of a media analysis on epigenetics (focusing on the German-speaking sector). Four recurrent themes were identified which mirror strands of discussion within public discourse.

Attentive Technologies - Guiding principles as an element of responsible research and innovation

Bernd Giese, *Universität Bremen, Germany*
Christian Pade, *Universität Bremen, Germany*
Arnim von Gleich, *Universität Bremen, Germany*

An early influence on innovation processes according to the principles of responsible research and innovation can greatly contribute to the optimal realization of opportunities and simultaneously to the minimization of risks. For this purpose one has to address a) the character of technological possibilities ("technology push"), b) the needs of users and stakeholders ("demand pull") and c) the scope of action for different players in innovation systems.
These factors are central for the approach of AttenTech, a feasibility analysis engaged in developing guiding principles for attentive technology. Guiding principles are assumed to be one of the crucial elements within the governance frame of responsible research and innovation. They should have a coordinating as well as trend-setting function within innovation processes by bundling, simplifying and balancing partially diffuse or contradictory demands (e. g. health and security vs. ethics and law).
Besides options for an early involvement of relevant stakeholders, AttenTech also identified technological requirements for the maximization of opportunities for users (activation, empowerment, participation, integration as well as self determination) and the minimization of risks (incapacitation, passivity, restriction, isolation or discrimination). Thus a technology of attentive and instrumental character is outlined, which fulfills a subordinate role:

Technology design should rather be determined by the needs and abilities of its users and not primarily by technical capabilities. Considering this background significant and promising technological trends in the field of robotics (e. g. companion systems) on the one hand, and the needs of society and different societal groups on the other hand have been identified and assessed in the light of demographic change.
In the review part of the project, the identified technological trends were analyzed regarding their potential to match the guiding principles of attentive technology. Moreover, the approach of AttenTech shows how far guiding principles can serve as elements of responsible research and innovation within the process of technological development.

3.3. Innovating with Care

Chair: Bettina Krings

'Care for the future' and re-embedding technoscience in society

Christopher Groves, *School of Social Sciences, Cardiff University, UK*

The normative basis of Responsible Research and Innovation (RRI), it has recently been argued, should be the need to 'care for the future' in the face of inescapable ignorance and uncertainties about the 'downstream' consequences and wider societal implications of using new technological artefacts. The use of 'care' here evokes Hans Jonas' warning that neither the 'existence' nor the 'essence' of humanity should be at stake in the 'hazards of action' (Jonas, 1984). But what values and practices of 'caring' can be adequate to the kinds of uncertainty, ignorance and ambiguity that are implicated within technological innovation? There are moral concepts of care that relate to how skills and knowledge should be used by their possessors, and which may be translated into legal notions of a duty of care (Koepsell, 2010). There are broader, ethical concepts of care which deal with the preservation and tending of individuals and forms of life (Kittay, 2013; Ruddick, 1989). There are also political concepts of care that deal with the mutual dependency of human beings and the claims on justice that may be derived from it (Engster, 2007; Tronto, 1993). Here, I outline why concepts of a 'duty of care' are insufficient to understand the sense in which 'care for the future' can be meaningfully understood as a dimension of innovation. I sketch a possible agenda for developing a more adequately fleshed-out concept of care relevant to RRI, one which draws on the work of Annemarie Mol (2008) and on the idea of constitutive value (Groves, 2011; O'Neill, 1993). Mol's work, I argue, alerts us to the centrality of how different kinds of temporality can shape innovations either in practice or in technological infrastructure in more or less 'care-full' ways. By examining the function of constitutive value within ethical and political theories of care, it is possible to understand more adequately the ways in which technologies are more than just instruments of pre-given human intentions. By placing these two theoretical contributions of ethical and political care approaches in the foreground of RRI, I suggest, it may be possible to develop an ethics of RRI that recognises a range of implications of what it might to 're-embed' technoscience within society, and thus may be adequate to RRI's normative ambitions.

Avoiding the linear model in RRI

Marianne Boenink, *University of Twente, The Netherlands*
Yvonne Cuijpers, *Utrecht University, The Netherlands*
Anna Laura van der Laan, *University of Twente, The Netherlands*
Ellen Moors, *Utrecht University, The Netherlands*
Harro van Lente, *Utrecht University, The Netherlands*

Innovation processes are often framed as a linear pipeline, with set moments to assess whether an innovation is sufficiently promising to proceed to the next stage. In practice,

however, as research in philosophy of technology and in science, technology and innovation studies has made abundantly clear, innovation is a non-linear, complex process, including many different practices with a variety of goals and values, and with many stakeholders, none of whom is capable of fully 'steering' what is going on. In this presentation, we investigate what this means for 'responsible innovation'. We will do so in the context of our research project on responsible innovation of diagnostics for Alzheimer's Disease.
In this research project, we frequently encountered processes and phenomena confirming the non-linear and complex character of innovation. For example, although the AD research consortium we collaborate with formally organizes its research in a rather linear way, in practice research evolves much less linearly. Moreover, the practice that the diagnostic tools are developed for is very diverse; there is no such thing as 'the' diagnostic practice for AD. And finally, the supposed role of clinical guidelines as a gatekeeper for innovations is much more complicated than the linear model of innovation allows for.
Starting from these observations, we explore what RRI in such a complex setting can mean. We will briefly discuss two often invoked definitions of RRI (von Schomberg 2011 and Owen et al 2012) and argue that, even though they explicitly acknowledge the non-linear, complex character of innovation, these do not suffice to deal with the observed complexities. In some respects, they still invite a linear view of innovation. Subsequently, we outline our alternative approach.
In this approach, innovation is viewed as a complex process of relocation and translation. New technologies are not introduced into a void; they interact with the practices in which they are introduced or emerge. It is important, then, not to disregard the values implied in existing practices. 'Responsible innovation' in our view assumes not only that stakeholders explicitly assess the potential benefits and drawbacks of a proposed innovation. In contrast, responsible innovation should carefully consider what is at stake in the different practices an innovation might travel to: it should be responsive to the values embedded in those practices. Moreover, the aimed for innovation itself should be unpacked: which ideas, values and materials are going into an innovation, what is necessary to realize the hoped for benefits, and what additional impacts can be anticipated, beyond the intended ones? On this basis, it is possible to chart the actual and possible interactions between existing practices and proposed innovations, and to determine how this interactive process could be improved in terms of facilitating connections and translation during the journey. Responsible innovation in this view means being responsive to the values embedded in the different worlds to be connected, and to proceed with care.

Care and responsibility in the development of early interventions for dementia

Richard Milne, *University of Cambridge, UK*

This paper develops a care ethics approach to thinking about responsibility and responsiveness in research and innovation, drawing on ethnographic work investigating the use of long-term epidemiological studies of dementia to develop early interventions into Alzheimer's disease (AD). It suggests that responsible innovation frameworks need to be locally adapted and embedded to avoid becoming "empty exhortation or insipid sloganeering" (Guston 2013). Dementia research is currently subject to a range of external policy and societal pressures that converge on new models of diagnosis and therapy. At the forefront of the future narratives that shape AD is the so-called 'ageing tsunami' – the rise in the older population and the expected increase in healthcare expenditure that goes alongside it. This is exacerbated by the inability of research to date to produce therapies that effectively modify disease progression. The failure to produce a 'cure' creates a consistent need to re-establish

and re-emphasise the promise of research, and a drive to re-orient research in new directions that provide implementable new technologies. This is supporting a push to earlier, biomarker-based diagnosis which moves the disease earlier in the lifecourse and raises the possibility of long term intervention.

The move of AD research to biomarkers raises significant ethical concerns about early diagnosis and the ever-longer futures within which individuals live with the label of 'prodromal' presymptomatic AD (Lock 2013). However, the validity of biomarkers and the interventions that may accompany them remain uncertain and speculative considerations of their future impact risk closing down other possible futures (cf Nordmann 2007; Bensaude-Vincent 2013). Focussing on a long-term epidemiological study of dementia currently involved in considering a shift to intervention, this paper argues for embedding responsibility in local contexts of research into ageing and dementia. It argues that this allows attention to shift to fostering responsiveness and the identification of collective obligations in research in the present. As such, it suggests the need for an approach that engages with the possibilities for responsibility afforded by the specific sites, temporalities, socialities and practices of research and innovation.

3.4. Visionary Technoscientific Practices: the Co-Constitution of Practice and Imagination (I)

Chair: Andreas Lösch

Scenarios as patterns of orientation in technology development

Ingo Schulz-Schaeffer, *Institute for Sociology, University of Duisburg-Essen, Germany*
Nils Kubischok, *Institute for Sociology, University of Duisburg-Essen, Germany*
Martin Meister, *Institute for Sociology, University of Duisburg-Essen, Germany*

Much research on technological future concepts has focused on visions, that is on the more broad and general ideas about the future, and on the rhetorical and political uses of visions in processes of establishing new fields of research or major projects of socio-technical change. In contrast, there is less empirical work concerning the question if and how future concepts actually provide guidance in technology development. To address this issue, it is necessary to focus on future concepts that spell out the imagined future in a more concrete way. For to be useable as guidance for activities of technology development, future concepts need to include sufficiently specific information about the components of the envisioned new technology, the features of the components, their performance and their interrelatedness.
In our talk we will present results from an empirical research project that investigates the role of future concepts as patterns of orientation in technology development. In this project we are focusing on situational scenarios as a type of future concepts that envision the future reality of a new technology within its imagined field of application in a rather concrete way. Our empirical data stem from two fields of technological research: the field of Ubiquitous Computing, where it is very common to refer to situational scenarios, and the field of Nanomedicine, where this type of future concept is seldom to be found. We have conducted interviews with about 70 researchers from both these fields in Europe, Japan, and the US. Based on these interviews and the corresponding content analyses of related research documents we will discuss the capacity of future concepts to provide epistemic orientation for technology development.

Visions of in-vitro meat

Arianna Ferrari, *Karlsruhe Institute of Technology, Germany*

On August 5, 2013, the world's first burger made from Cultured Beef was cooked and eaten in London. This burger was the result of the scientific research conducted by the group lead by Mark Post at the University of Maastricht, who continued the study funded by the Dutch Government some years before. First formulated by Winston Churchill in the 30ies, then seriously considered by NASA as a possible alternative food for astronauts, the vision of in-vitro meat has gained renewed attention, profiting from developments in molecular biology (such as notably the isolation of stem cells) and the emergence of tissue engineering. For his research Post received the World Technology Award for Environment in November 2013 due to the innovative work of "the greatest likely long- term significance" in his scientific field.

Despite the availability of different techniques for this purpose, the creation of in-vitro meat still has to overcome different technical burdens, which render this enterprise economically inefficient: Post's burger was produced at the cost of about $325,000.
The production of muscles and tissues on a dish using animal cells and proteins which foster tissue growth has been extensively promoted by scientists as an environmental-friendly, safer and more ethical way of enabling meat consumption. Furthermore, this research has been praised by some animal welfare organizations, such as PETA (which even launched a prize), by parts of animal rights scholars and by the transhumanist movement. Interestingly enough, concerns have been raised by environmental organizations such as Friends of the Earth US, who argued that this technological fix distracts from the more authentic sustainability work which comes from small farmers.
In the paper I will provide an analysis of the different visions connected with the promotion of in- vitro meat by different actors, most notably by scientists as well as by some scholars motivated by animal welfare and animal rights. I will also engage with critical arguments brought by another part of animal rights scholars as well as by environmental organizations. Aim of the research will be to disentangle the normative framework of the different visions at play, based on different ideas on the role of technologies in society as well as on human/animal/environmental relationships.

Cyborgism and the Transhumanist Vision

Christopher Coenen, *Karlsruhe Institute of Technology, Germany*

Potentially, radical impacts of new or emerging technoscience on human corporeality and civilisation have become – again – the subject of major international discussion since the early 2000s. In discourse on 'converging technologies' and 'human enhancement', an important role is played out by transhumanism, a worldview and movement promoting a future in which human civilisation and corporeality have both been utterly transformed by technoscience. Transhumanism's visions of the future include besides the widespread use of human enhancement technologies the 'uploading' of individual minds onto hardware, their quasi-telepathic interconnection with and the extraterrestrial expansion of the transformed species. As an organised movement, transhumanism is small, yet it is not without influence, for example in bioethics. As a worldview and broader intellectual movement, it could be conceived as an important element of modern culture, for example with regard to the science fiction genre. Furthermore, it has also become evident that transhumanism is a kind of worldview for parts of the technical elite in particular in the U.S. where key players in the computer and Internet industry directly support transhumanists, promote their ideas and have launched activities in their firms that have a decidedly transhumanist flavour.
Transhumanism's grand narrative about science, technology and the future of human nature does, however, not form the ideological basis for all social practices and cultural movements relevant to discourses on more radical visions of human enhancement. The rather old-fashioned modern- progressive ideology of transhumanism is but one element of a variety of developments in which human corporeality is technoscientifically re-defined and re-designed. Not all of the new cyborgs who technologically often follow the footsteps of either the researcher Kevin Warwick or the performance artist Stelarc are followers of transhumanist ideology or indeed, if they know it, reject its grand narrative. Some of them are inspired for example by Donna Haraway's cyborg feminism or other intellectual traditions that are critical of "classically" modern beliefs in progress. Attempts to extend human bodily faculties by means of implants do not always seek to improve individual competitiveness.

Current cyborgism (or do-it-yourself transhumanism) may lead to a diversity of body modifications, not all of them compatible with transhumanism's grand narrative about the future.

4.2. Emerging Body Technoscience Interrelations

Chair: Marianne Boenink

Business models, social justice and 'ragged edges': Some challenges of personalised cancer medicine

Anne Blanchard, *Centre for the Study of the Sciences and the Humanities and Centre for Cancer Biomarkers Allegaten, Bergen, Norway*

Cancer research is currently undergoing important changes: in parallel with more traditional forms of cancer therapy, such as 'blockbuster' drugs and chemotherapy, cancer research is now focussing on personalised medicine that is tailored to each patient (or group of patients) (ESMO, 2013). The prospects of personalised medicine are pictured as targeting cancer cells with high precision, sparing patients the dangerous side effects of more traditional cancer therapies (Fleck, 2014). One central feature of personalised medicine is research on 'cancer biomarkers', which would help elicit whether patients are likely to benefit from a given therapy and at which optimal dose (Trusheim et al., 2007).

However, personalised cancer medicine is anticipated to face many ethical questions and socio- economic challenges. The paper will discuss three of them, on the basis of a literature review and a set of interviews of medical researchers and practitioners, and actors from the pharmaceutical industry in Norway.

The first challenge is an economic one. Personalised cancer medicine is anticipated to be unattractive to the pharmaceutical industry: classic 'blockbuster' drugs such as Herceptin against breast cancer are currently prescribed to large patient populations, reaching more than $ 1 billion sales per year in the US; whereas tailored drugs will focus on very small groups of patients. This will challenge the business model of pharmaceutical industries by reducing the size of the market for each anti-cancer drug (Trusheim et al., 2007).

The second challenge is that of social justice, and is linked to the first one. When private industries are reluctant to fund research on cancer biomarkers, should the burden be placed on society, no matter the costs? Who is to legitimately benefit form personalised medicine? Can cancer biomarkers help us make a choice?

The third challenge is that of human complexity, or 'ragged edge' as Fleck (2012) labels it. Cancer biomarkers will indeed help distinguish patients who may react positively to a therapy, and patients who may not; and thus, the patients who have the strongest claim to personalised therapy. However, the clinical reality is such as there is no sharp boundary between patients. How and where, then, to draw a fair line for allocating personalised therapies?

We argue that to achieve some kind of social justice relative to these questions, post-normal science could help reach compromises among actors from the pharmaceutical industry, to citizens (including patients) and medical researchers and practitioners.

Between preservation and transformation of the body: the ambiguity of modern techniques through hacking

Bárbara Nascimento Duarte, *Federal University of Juiz de Fora, Brazil, and University of Strasbourg, France*

Currently, body, science, and technology are experiencing a period of deep challenge, facing a new global connectivity that also creates new grounds for their association. Scientific, rational and technical "progress" isn't always linear; there are other dimensions whose breadth must be considered, especially its implications in the social reality. The mechanization of the human being presents a rational and fruitful reading inspired by the success of the biotechnical imaginary. Scientific and technical innovation opens a commonplace for experimentations, as consequence we can gradually notice uncontrollable effects related to the transfiguration of human species. In this proposal, a look is taken at some realistic physical transformations possible now and led by individuals inspired by the vision, imagination, expectations of the emerging technologies. This essay develops its idiosyncrasy by concentrating primarily on the trend of body hacking. The practitioners, defined as body hackers, work in different ways to develop functional and physiological modifications through the contributions of technology. Their goal is to develop empirically man-technique fusion by themselves. These dynamic "scientific" subcultures are producing astonishing innovations. From pocket-sized kits that sample human DNA, microchip implants that keep tabs on our internal organs, blood sugar levels or moods, and even 3D printers that produce tailored hip replacements, the technical innovations of the body hacking movement are beginning to filter into mainstream use, and the repertoire increases every day. We must place ourselves in the heart of these social-technical exchanges where the collective imaginary resonates with the scientific and technical performances. This echo can incarnate in representations of human body in precise and coherent ways, defining how individuals will represent their bodily future. Thus, these physical transformations we will mention here actively challenge long-held normative beliefs about what bodies do, what they should look like and how they should behave.

Emerging Technologies: the approach of Constructive Technology Assessment (CTA) in Brain-Computer Interface (BCI) Research

Gabriel T. Velloso, *Karlsruhe Institute of Technology (KIT), Germany, and New University of Lisbon, Portugal*

Technology Assessment (TA) is an approach, a collective of systematic methods to investigate
technological developments and evaluate its potential impacts within society. Anticipating impacts of emerging technologies is a challenging undertaking, once a great deal of uncertainties and emerging development paths not always lead to a significant future. The dynamics of technological trajectories arise from actions and interactions amongst various actors and stakeholders involved; when understanding these dynamics they can act more reflexively and better shape future development directions. The participatory approach of Constructive Technology Assessment (CTA) offers a comprehensive and active process in evaluating potential social impacts and perspectives for emerging technologies. Through the engaging of different actors and a mutual sharing of information, a broadening of perspectives is achieved, widening their view of the innovation process and the possible consequences of

new and existing applications. Adjustments and corrections of paths could then take place, offering feedback into ongoing choices and strategies.
A Brain-computer interface (BCI) is a system which measures central nervous system (CNS) activity and converts it into artificial output without using the normal pathways of peripheral nerves and muscles, thereby changing the ongoing interactions between the CNS and its external or internal environment. Although BCI is still in its early stages of development, current research and applications show increasing possibilities for even further improvements. BCIs are present in many areas, but specifically its medical applications allow for the replacement, restoration, enhancement, improvement and supplementation of human functions. This clearly raises many questions about ethics, morals and responsibility. This article aims to reflect upon how the BCI community has been assessing the ethical, moral and philosophical issues as well as to investigate if a CTA approach is being put in place, even if not in a conscious way. Moreover, an explicit integration of the ethical dimension into the TA approach and in Science,
Technology and Society (STS) studies is expected from the Responsible Research and Innovation (RRI) perspective. Thus this article also seeks to highlight the importance of assessing and prioritizing possible ethical, moral and philosophical impacts as well as related risks and opportunities for the present and future.

4.3. Acceptance

Chair: Julia Hahn

Individual and Social Acceptance of Nanotechnology Use for Tissue Engineering Applications: Perspectives from Patients, Laypeople and Healthcare Professionals

Marie-Sol Poirier[1,2]
Vanessa Chenel[1,2,3]
Johane Patenaude[1,2]
Patrick Boissy[1,2]
the InterNE3LS Group
1 Interdisciplinary Institute for Technological Innovation (3IT), University of Sherbrooke, Canada, 2 Faculty of Medicine and Health Sciences, University of Sherbrooke, Canada, 3 Lyon Nanotechnology Institute (INL), Centrale Lyon, France

Background Nanotechnology applications in medicine such as the use of carbon nanotubes (CNTs) for tissue engineering scaffolds offer potentially great benefits to patients. Skin grafts based on CNTs scaffolds are currently being developed and could be beneficial in the treatment of numerous diseases. However, concerns from experts and laypeople over the use of nano-materials with potential toxicity exist and lack of knowledge of the public acceptance for such application remains. A high variability of acceptance is also observed in laypeople, especially because acceptance can be defined in two ways: individual acceptance (intention of use) and social acceptance (what is desirable for the society). The objective of this study is to explore the influence of different profiles of laypeople on individual and social acceptance of using skin graft based on CNTs scaffolds in the treatment of diabetic foot complications.

Methods An exploratory study, with an online questionnaire was used to assess the individual and social acceptance in a French Canadian population living in the province of Québec. Invitations targeting specific groups (diabetic, healthcare professionals and non-diabetic) were posted on social media, clinical research websites and email lists from different interest groups. The questionnaire consisted of a vignette illustrating the use of a skin graft incorporating CNTs to treat diabetic foot complications and measured individual acceptance (favourable, not favourable) and social acceptance. The influence of groups, health status, and caregiver status on individual and social acceptance rates was examined.

Results and conclusions Analyses were performed on complete questionnaires (n=270): diabetic (n = 63), healthcare professionals (n = 80), and non-diabetic (n = 127). No difference (□2 test, $p > 0.05$) was found between groups for individual acceptance, but a difference was found for social acceptance. Healthcare professionals when compared to other groups viewed less favourably for the society the use of the skin grafts based on CNTs scaffolds. Controlling separately for the groups (diabetic, non-diabetic, healthcare professionals) and the caregiver status (healthcare professionals or not), results showed that the respondent profile influenced the relation between individual and social acceptance rates (Mantel-Haenszel, $p < 0,001$). While diabetics see favourably the use of the skin graft for themselves or society, healthcare professional are less favourable for individual and social acceptance. Knowledge about

recurrence of pressure ulcer in a diabetic population and potentially high cost of skin graft based on CNTs may explain why the caregiver status influence the relation between individual and social acceptance.

Acceptance and Acceptability of Drug-Delivery Nanocarriers in Different Contexts of Use: Perception of Researchers in the Field of New Technologies

Vanessa Chenel[1,2,3]
Marie-Sol Poirier[1,2]
Johane Patenaude[1,2]
Patrick Boissy[1,2]
the InterNE3LS Group
Interdisciplinary Institute for Technological Innovation (3IT), University of Sherbrooke, Canada[1], Faculty of Medicine and Health Sciences, University of Sherbrooke, Canada[2], Lyon Nanotechnology Institute (INL), Centrale Lyon, France[3]

Purpose: Nanotechnologies and their applications in medicine and health care mark a new era of technological development. While the promises and benefits of nanomedicine applications such as the use of drug-delivery nanocarriers are being studied, some uncertainties remain toward acceptance (intention of use) and acceptability (value judgment explaining the intention of use) of such applications. The objectives of this study were to explore how individual and social values of researchers from several cultures affect acceptance and acceptability of drug-delivery nanocarriers in different contexts of use.
Method: Acceptance and acceptability of two drug-delivery nanocarriers (carbon; DNA) in two contexts of use (treatment of lung cancer; treatment of influenza) were measured using an exploratory mixed-method approach with sequential data triangulation. An online 10 questions scenario-based survey was developed. An invitation to participate was sent to 1527 active researchers in the field of new technologies. Qualitative interview were conducted on 10% of respondents to confirm and extent the themes addressed in the online survey.
Results and conclusions: Data were analyzed from completed questionnaires (n=214) filled by researchers from social sciences, humanities (n=71) and natural sciences (n=143) in both Europe (n=141) and Canada (n=73). A significant relation (MacNemar's test, $p<0,001$) was found between usage context and intention of use; respondents were more willing to use the carbon nanocarriers to treat lung cancer than to treat influenza. The respondents profile did not influenced this relation (Mantel-Haenszel test's, $p>0,05$) when controlling for the research experience, the social and the disciplinary culture. Overall, no significant relation was found between the nature (carbon; DNA) and the acceptance, when the nanocarriers is used to treat lung cancer (MacNemar's test, $p>0,05$). However, controlling separately for occupation ($p<0,001$), social ($p<0,001$) and disciplinary culture ($p<0,001$), results show that the respondent profile influence the relation between the nature of the nanocarriers and the acceptation. Severity of the disease and uncertainties concerning clinical outcomes may explain why intention of use is much higher to treat lung cancer, comparing to influenza, a disease presenting a low level of risk to health and life if not treated. The perceived risks of not being treated from lung cancer may explain why the nature of the treatment does not influence the acceptance. The interpretation of qualitative interviews on how and why do respondents use or reject treatments will lead to a much more complete understanding of the acceptability of presented nanocarriers.

Public attitudes and the enhancement spectrum

Laura Y. Cabrera, *National Core for Neuroethics, University of British Columbia, Vancouver, Canada*
Nicholas S. Fitz, *National Core for Neuroethics, University of British Columbia, Vancouver, Canada*
Peter B. Reiner, *National Core for Neuroethics, University of British Columbia, Vancouver, Canada*

Cognitive enhancement has been a heated debate in the past year. The therapy-enhancement distinction has been the main framework shaping the discussion. Some scholars have argued that rather than thinking in binary oppositions we should see enhancement cases as relative spectra of variation (Bess 2010). We considered the possibility that this variation contributes to the angst that the public expresses with respect to the issue of cognitive enhancement, and set out to develop empirical data that explored this issue.
We used Mechanical Turk to recruit respondents (*n = 2776*) from Canada and the United States and used the contrastive vignette technique to explore public attitudes regarding sources of angst about cognitive enhancement. In particular we set up a situation in which a vignette described a close friend using a pill either to enhance above the norm (EAN) – essentially, what is commonly thought of as enhancement – or to enhance to the norm (ETN) – the poorly-defined borderline situation between therapy and enhancement. For each enhancement condition we tested how comfortable participants were with the intervention across twelve different cognitive domains: alertness, attention, cooperation, creativity, empathy, mood, narrative memory, openness to experience, perseverance, self-control, sociability and working memory.
For 9/12 domains, participants were more comfortable when the intervention was described as ETN than when it was described as EAN. These results are consistent with the hypothesis that our participants were viewing ETN as a form of quasi-therapy, and that this led to greater comfort with ETN as compared to EAN. To explore this issue further, we allowed participants to complete a free-response box in which they were asked to tell us why they answered as they did. After carrying out mixed methodology analysis, the most striking result came from the theme "No Need"; 608/1408 participants opined that they were uncomfortable with the situation because there was *no need* for the pill when the condition was framed as EAN, while only 227/1368 participants felt similarly when the condition was framed as ETN. This exploratory research shows that people are sensitive to variations of enhancement, and as such if we are to have a more coherent ethics of enhancement we have a social responsibility to explore further how these differences affect public attitudes towards enhancement.

4.4. Visionary Technoscientific Practices (II)

Chair: Christoph Schneider

Understanding Anticipation through Practices

Carla Alvial Palavicino, *STePS, University of Twente, The Netherlands*
Kornelia Konrad, *STePS, University of Twente, The Netherlands*

Forecasts, Scenarios or Roadmaps are more and more recurrent elements of scientific and innovation activities, now found as part of grant proposals, consortia, technological platforms and funding schemes. These are particularly prominent in the case of emergent technologies and new research fields, such as nanotechnology or synthetic biology, where technological and social pathways are highly uncertain.
While these exercises are aimed at creating some form of knowledge about the future, their effect lies not so much in their "predictive power", but in the performative effect of the expectations they raise. The existence of these and other practices, actively engaging in anticipation a wide range of actors, reflects the relevance of expectations for the definition or sense making, legitimation, guidance and coordination of science and innovation activities today.
The Sociology of Expectations has extensively studied the performative effect of expectations - as visions, promises, or concerns - and its relation with innovation strategies and activities. However, less attention has been given to systematically study the ways in which "knowledge" about the future is created, more specifically the practices in which anticipation is embedded. The paper to be presented contributes to our understanding of the specific performative aspect of different "anticipatory practices". Anticipatory practices are forms (explicit or implicit) through which the future is disclosed, known, and governed, thus becoming a cause of action in the present. They appear in the form of formal anticipation [or dedicated anticipation, such as the earlier mentioned roadmaps, scenario exercises and others] and anticipation embedded in ongoing activities and materials such as science publishing, patents, prototypes, conferences and others [anticipation in action].
A practice perspective allows a detailed understanding of the relation between the circulation of expectations, and the material, institutional, and socio-cultural conditions that support the emergence of particular versions of the future. As part of specific "Regimes of Anticipation", anticipatory practices take part in processes of anticipatory coordination and broader governance arrangements.
This presentation will provide a discussion of the approach, illustrating it with two comparative case studies in the areas of 3D printing and graphene.

Governing the difference between the future and the present: chronopolitical ideal types

Mario Kaiser, ZRWP, *University of Basel, Switzerland*

The notion of chronopolitics seems to be capable for coping with the complex interdependencies between visions and practices. In my contribution I would like to offer a

concept of chronopolitics that differs from Paul Virilio's diagnosis, as it focus less on time as a scarce resource, but rather on the difference between the future and the present. In this sense, chronopolitics is conceived of as the set of strategies and techniques aimed to govern the difference between future and present.
Against this conceptual background, I will examine different types of reactions to 'uncomfortable' futures or visions (disasters, crises, catastrophes). Thus, my interest lies less on the social construction of such futures in a particular context of practice, but rather on the ideal typical ways, with which various actors try to handle the feared futures in the present. The overarching goal of such an analysis of temporal power consists in the elaboration of an inventory of the most dominant forms of governing the future-present difference of our time. Besides the ideal types of prevention and preemption, my talk aims at elaborating on a further candidate, we may call simultation. On a pilot basis, this type of chronopolitics can be understood as an answer to two requirements: simulating the future on the one hand, deliberating and reflecting the future's implications in real-time or at least as simultaneously as possible.

Visions structuring the debate: the case of the President's Council on Bioethics

Stefan Gammel, *Institute for Philosophy, Technical University Darmstadt, Germany*

The President's Council on Bioethics (PCBE) was established by US President George W. Bush to advise the US-administration on issues concerning the advance of biomedical science and technology. It was created in 2001 by executive order and expired in 2009 and replaced the *National Bioethics Advisory Commission* (1996-2001, Bill Clinton) which was itself replaced in 2009 by the *Presidential Commission for the Study of Bioethical Issues* (Obama). All councils / commissions and their members were appointed by the respective president of the US and allegedly chosen to support the political (or ideological) preferences of the administration. Especially the history of the PCBE and the reasons put forward by the Obama administration to establish a new commission are interesting, because it illustrates how visions concerning human nature and technological progress can influence the work of such an advisory body, and how an advisory body can influence public debate and politics with its own kind of visions that form a certain world view. Also interesting is the conflict around the dismissal of the molecular biologist Elizabeth Blackburn from the council because of diverging opinions concerning stem cell research and abortion. In this paper I want to discuss, how (positive and negative) visions concerning human nature and technological progress structured the debate between transhumanists, bioconservatives and 'bench scientists' in the setting of an advisory body in the field of politics.

5.1. Futures and Imaginaries

Chair: Michael Bennett

Mnemonic images in nanotechnoscience

Rasmus T. Slaattelid, *Center for the Study of the Sciences and the Humanities, University of Bergen, Norway*

The paper is based on a reading of the memory section in *Rhetorica ad Herennium* (RH) – our most complete source to ancient thinking about the mnemonic function of images. The paper aims to investigate the relevance of RH for understanding some aspects of scientific visualisations. RH describes how images of things or states of affairs (*res*), organized into a system of pre-memorized '"backgrounds", function as mnemotechnical tools to recall speech. In order to explain the specificity of the relationship between images and (system of) backgrounds, the RH uses the analogy that, just as someone who knows the alphabet can write down what they hear, and then read it aloud, so someone "who knows mnemonics can set in backgrounds what they have heard, and from these backgrounds deliver it by memory" (III, 30).
The mnemotechnical tradition has been traced through Late Antiquity, via the Middle Ages up until the 16th century by Yates, Rossi, Carruthers and others, revealing the significance of the technology of memory for the creative exploration and transformation of received knowledge. The paper explores what insights this tradition can yield into the ways in which images function in the discourses of emerging technologies, as well as in the exploration of their technoscientific potential.
A collection of examples will be analyzed using tools developed in the memoria- literature in classical and medieval rhetorical theory. Analyzing some well-known examples of visual displays of quantitative data from nanotechnoscience the paper suggests that insights from the *memoria*-tradition in classical rhetoric can help us understand better these visualizations.

Can we think nano-ecology?

Zach Horton, *Center for Nanotechnology and Society, University of California, Santa Barbara, USA*

This presentation approaches the nanotechnological imaginary—a cultural-material assemblage of futurist nanovisions, probe microscopy techniques, and science fictional explorations of nanoworlds—from the perspective of a trans-scalar ecological thought. Nanotech, in its exploration, mapping, and harnessing of an alterior nanoworld, contains the potential to think this world as an ecosystem, and its accompanying knowledge practices as a radical ecology. I will examine the iconic debate between two of nanotech's founding fathers, Richard Smalley and K. Eric Drexler, as a debate about whether or not we can approach the nanoscale as an ecosystem, and which scale-sensitive disciplinary methods are appropriate to such an engagement. The question of nano-ecology is analyzed as both a trans-scalar knowledge practice and a trans-scalar ecosystem. Engaging nanotech—and thus the nanoworld—in this way has significant implications for both ecology and nanotechnology.

Nanoscale entities are not considered to be alive by traditional human knowledge practices, and yet exhibit many of the qualities of life, confounding our notions of what an ecosystem can be. Similarly, nanotechnology researchers and others who engage the nanotech imaginary in creative and pedagogical modes may benefit from approaching the nanoworld not as a landscape—a surface for contemplation and inscription—but as an ecosystem, or a set of interdependencies in a constant state of self-organization and becoming. I will suggest that ultimately, freeing the virtual potentials of nano-ecology requires both suspending our anthropocentric transposition of industrial forms onto other scales as well as breaking down disciplinary boundaries that fix scale and delimit knowledge production.

On Responsibility: the Scientist between Master and Creator

Alexei Grinbaum, *CEA-Saclay, SPEC/LARSIM, France*

If legal forms of responsibility mostly apply "down the chain" and concern the industrialist or the engineer who sell and design market goods, what kind of responsibility incurs to the scientist? For he surely has one, because he feels responsible and also because he is assigned a certain moral responsibility by the layman. We argue that this responsibility has two main sources: the scientist's bringing novelty unto the world (Creator), and the scientist's intimate knowledge and first-hand command of whatever new ideas or things he has introduced (Master). The tags we use for these two streams of responsibility stand themselves in need of clarification: why Creator rather than Innovator? and the Master of what? Firstly we respond to these questions. Secondly, we use two key historic narratives to emphasize the meaning of Creator's and Master's responsibilities as well as their limitations. These narratives are: a complex relationship between Rabbi Loew of Prague and his golem who subsequently turned berserk, and the history of the notion of noxal surrender in Greek and classical Roman law, i.e. an analysis of responsibility that preceded the contemporary Summa divisio of all legal entities into persons and things. The scientist's responsibility does not coincide with a notion of responsibility employed in either of these stories; still, both narratives elucidate the salient, even paradoxical points of how the scientist is de facto being held morally responsible in a world that only seems to ignore the ancient forms of responsibility, but in effect tacitly deploys them when it must deal with the ethical puzzles put forward by emerging technologies.

An Examination of the Use of Futures in Contemporary Anglo-American Legal Thought

Michael G. Bennett, *Northeastern University School of Law, Boston, USA*

Futurity is fundamental to much Western legal thought and practice. Legally enforceable agreements are traditionally focused on fixing future events; litigation strategies are often designed to achieve decisions that constrain actors in the future; the meting out of punishments for criminal breaches of law often entails strict controls on future activities, occasionally even forcing a irrevocable forfeiture of one party's future; statutes of limitation on legal actions and the equitable doctrine of laches are designed to promote justice by buffering court proceedings from difficulties of addressing claims that arise beyond a point in the future at which evidence and memories are likely to have been misplaced and faded. These aspects of law represent only a fraction of the objects, activities and concepts that sensitize and orient legal actors and institutions toward events that have not happened yet. Assessments of possible futures and deployments of futural figures represent approaches to

engaging the future that, though implicit in some traditional modes of legal thought and practice, are much less commonly explicitly invoked or situated at the center of legal strategy, research methods or theoretical framings. However, these modes have become more prominent in discourse of both legal practitioners and academic lawyers during the last two decades. Using three texts of considerable influence in contemporary legal thought and practice—Posner's (2004) *Catastrophe*, Lessig's (2006) *Code 2.0* and Susskind's (2013) *Tomorrow's Lawyers*—this presentation will situate legal futures assessment and futural figure deployments within the context of future-oriented analytical methods from science and technology studies literatures, particularly sociology of futures, philosophy of technology and philosophy of science. The main goals of this exercise are to attempt to determine what type of work deployments of future assessments and futural figures do for legal scholars and practitioners, and to begin to assess the value that legal practitioners and scholars might extract from a broader engagement with future-oriented studies.

5.3. Synthetic Biology

Chair: Steffen Albrecht

Corporate research and development activities in synthetic biology

Luciano Kay, *Center for Nanotechnology in Society, University of California, Santa Barbara, USA*
Jennifer Woolley, *Leavey School of Business, Santa Clara University, USA*

This paper investigates research and development (R&D) activities of companies that enter the domain of synthetic biology to understand the corporate strategies and significance of commercializatio activities in this emerging field. Synthetic biology (or simply "synbio") refersto the design and fabrication of biological components and systems that do not already exist in the natural world and the re-design and fabrication of existing biological systems. Experts anticipate significant industry, social and ethical implications of the development of synbio technologies, which have applications as diverse as pharmaceuticals, human performance enhancers, industrial chemicals, energy and agricultural products (Church et al. 2014). Other research has mapped the growing, albeit still nascent, scientific activity in this field (Oldham et al. 2012).
This research draws on lists of companies that have been identified as synthetic biology R&D performers and the analysis of scientific publication and patent data extracted from Thomson Reuters Web of Science and EPO Patstat, respectively. Other documentary sources support the analysis as well. The paper discusses the process of identification of synbio firms and relevant scientific and patent literature to assess the significance of commercialization activities.
It also profiles corporate synbio activities worldwide an elaborates on the classification of synbio activities offered by the literature to propose a taxonomy of firms that can support further research.
Finally, this paper discusses the challenges that firms face and the potential implications of the development and commercialization of synbio technologies.

Expectations and emerging community: the case of synthetic biology and microbial biofuels in the EU

Celso Gomes, *Department of Sociological Studies, University of Sheffield, UK*

Communities as social units have been a topic of considerable theoretical interest within STS – be they of practice, promise or transaction. The processes through which communities emerge, however, have received far less attention and little empirical investigation. Thus, in this paper I describe an empirical study on a collaborative research project funded under the European Union's Seventh Framework Programme to explore how a community is emerging around the use of synthetic biology for the production of microbial biofuels. I do so by drawing on insights from the sociology of expectations and on *community-making devices* –

devices that help build communities by acting as beacons that instil a shared sense of belonging of individuals and sets of practices and which people and practices rally around. Three such community-making devices stood out during the study: the structure of the research project; the open days of project meetings (with invited participants); and the biological repositories started within the project. I contend that these devices contributed to shaping the emerging community, but were constrained in how to shape it. I further link those constraints to expectations of how EU research (and synthetic biology in an EU setting, in particular) is to be accomplished shaping the devices themselves. Community-making devices thus perform a balancing act between promoting a sense of collective while at the same time allowing for incorporating constraints. To illustrate this point, I explore how the increasing variety of disciplinary backgrounds, the increasing interdependence between reserachers and the increasing link between research goals and funding pressures were negotiated. This contribution aims to build on the body of literature on the role of expectations by suggesting a new mediated role in the emergence of communities.

5.4. Visionary Technoscientific Practices (III)

Chair: Mario Kaiser

Smart Grid experiments as producers of the presents and futures of the energy transition

Andreas Lösch, *Karlsruhe Institute of Technology, Germany*
Christoph Schneider, *Karlsruhe Institute of Technology, Germany*

The German energy transition is often seen as an experiment. The main characteristic of the transition is said to be the decentralisation of the established centralised energy system due to the integration of renewable energies. Many argue that the success of the transition depends on the establishment of smart grids, which shall "intelligently" steer the provision and consumption of energy on all levels of the energy system in the future based on ICTs. This furthermore implies strong changes in the behaviour of actors and in the routines of organisations.
Based on expert interviews concerning field tests with smart grids our hypothesis is that the transformation processes of the energy transition take place as heterogeneous and interdependent experiments (plural) that address technical designs and forms of action and organisation. These technoscientific experiments in society are being enabled and coordinated by visions of future smart grids which in turn are being reconfigured by experiments. The imaginations that are addressed by
6these experiments are rather general visions of smart grids. Yet, depending on the experimental setting of the field tests these visions are differently interpreted, specified and realised. In this way, visions of future smart grids enable and legitimise experiments with technical designs as well as experiments with regulation, markets, consumers or grid operators. The visions relate experiences and expectations and thus show interfaces between established and not-yet established structures, which in turn are experimentally tested. Experiments entangle practices and visions by creating novel combinations between old, new and not-yet established components of the energy system. Through this, the experiments change technical designs, forms of action and organisation and in turn visions of smart grids. Therefore, the experiments of the energy transition produce their futures and presents. Due to their undetermined effects the experimental practices are an important aspect for the investigation of the transformation processes of the energy transition.

'I've decided it's best to be confused': the co-evolution of technological infrastructures and future imaginaries in a West Wales low-impact community

Christopher Groves, *School of Social Sciences, Cardiff University, UK*

The role of future imaginaries in influencing technological evolution through the production of expectations is well-attested (e.g. Borup et al., 2006). However, the emphasis has often fallen mainly on the role played by imaginaries within the development phase of new technologies. Yet when technologies are taken up within society, they take their place

alongside *meanings and competences* as elements of practices, where practices are understood as purposive social activities (Shove et al., 2012). Changes in one of these elements may effect changes in others, creating social transformations in turn. Future imaginaries may be understood as ingredients of the meaning of practices, particularly in cases where practices aim themselves at achieving social transformation. Part of the meaning of practices, however, is how they *matter* to individuals and to groups (Sayer, 2011): as well as being purposive activities, practices are also constituents of identity and conditions of agency, and are interwoven with affective, future-oriented states such as hope or anxiety. In addition to being ways of 'getting things done', they are also affectively and symbolically significant ways of giving shape to an uncertain future – a function in which future imaginaries play a key part. Good examples of experimental practices which manifest all these aspects are those involved in explorations of more sustainable ways of living, in which future imaginaries of 'self-sufficiency' constitute important symbolic and affective resources – not least insofar as they help constitute the reflexivity of these practices towards 'mainstream' ways of living, and towards the meanings, competences and infrastructures that compose them. This paper examines how imaginaries and technology use co-evolve as a result of the performance of experimental, sustainable practices, with the aid of an analysis of narrative interviews undertaken with participants from the Tir-y- Gafel/Lammas low-impact community in West Wales, one of the four communities studied by the Energy Biographies (http://energybiographies.org) project at Cardiff University. Imaginaries of self- sufficiency are shown to be a key element in how participants make sense of an uncertain future. These imaginaries enable reflexivity both towards technology choice and use across a range of practices relating to every aspect of household and communal life, as well as guiding improvisation in response to unforeseen situations. At the same time, technologies – ranging from hydroelectric generators and solar panels to tablet computers, fridges and power tools – introduce reflexivity towards the idea of self-sufficiency itself, leading participants to question core elements of this future imaginary, and in particular, the degree to which it can provide normative guidance in technology choice and use. While imaginaries shape the social use of technologies by stimulating bricolage and improvisation, the dependencies embodied by technologies are shown to gradually emerge, in practice, as factors that can place in question the consistency of imaginaries and induce normative change. It is thus demonstrated that technologies are not just substitutable means towards predefined ends, but may also reshape what are taken to be viable and desirable social purposes.

Economy of Promises in Climate Change Research – Nanoparticels in the Stratosphere

Astrid Schwarz, *ETH Zürich, Switzerland*

It is claimed that nanotechnologies afford materials and surfaces that have beneficial features likewise for the human body and its environment. Accordingly, they also may refer to health issues of the planet, mainly its steadily growing fever curve, global warming. The promised application in this case are engineered nano-sized discs that are able to scatter sunlight and that are expected to exploit photophoretic forces, enabling more control over particle distribution and lifetime. In both cases, the planet and the human organism, it is assumed that there is a single self-regulating organism at work. According to the Gaia hypothesis, the earth can act like a self-regulating organism. In my presentation, I will investigate the concept of self-organization, and mainly, to what extent the concept of health relies on ideas of reciprocal action and material exchange. I will be investigating in which way stratospheric nanoparticles contribute to the economy of promises of a recovery of the 'blue planet'.

6.2. Road Mappings

Chair: Kornelia Konrad

Conflicts of interest in the IPCC repotz on Carbon Capture and Storage (2005)

Erik Thorstensen, *Oslo and Akershus University College (AFI), Norway*

Technological solutions to mitigate climate change are now in full development worldwide. These solutions might take a variety of forms from what can be seen as very close to nature or mimicking nature, as for example reforestation and afforestation to bind carbon or increasing the number of clouds for solar radiation management, over to solutions connoting heavy industry as mounting carbon capture and storage (CCS) technologies to new or existing installations in the production chain of energy from fossil fuels or biofuels.
Through the IPCC system the mitigation of climate change and greenhouse gas emissions is drawn up by experts providing facts with degrees of certainty and confidence. This paper will study the authors and the editors authors contributing to the Intergovernmental Panel on Climate Change' s 2005 report *Carbon Capture and Storage* and document the extent of patent-holders on CCS-related technologies on the mentioned panel. Preliminary investigations suggest that several panelists held patents and that there are suggestive differences between the different chapters in the 2005 report. To hold a patent on CCS technologies and provide advice to the possible uses of CCS technologies as a mitigation strategy might constitute a conflict of interest. The national spending on CCS technologies seems to stand in proportion to the degree of income from fossil energy. In such a case, it can be argued that conflict of interest might not only be between private vs. public interest, but also between diverging public interests. Diverging public interests is central to controversies as how to distribute goods and bads when mitigating climate change. Even though this paper is critical towards the high presence of patent-holders in Working Group III of the IPCC, there is no suggestion that these findings have a bearing on the science of climate change as reported by Working Groups I and II of the IPCC.

Nanotechnology "Roadmaps" and Related Metaphorical Concepts in the European Commission's R&D Reporting

Pavel Kotlík, *Université de Strasbourg, France*

In my presented study, I focus on a particular practice of „knowing" the socio-technical landscape and so called technology „roadmapping" in the context of European Commission's (EC) Research and Development Policy. Technology roadmapping is described in the theoretical literature as a flexible method widely used to support strategic and long-range planning, including tracking the performance of potentially disruptive technologies. This study introduces technology roadmapping in the context of nanotechnology, while exploring the concept under the scrutiny of metaphor analysis in the Community Research and Development Information Service (CORDIS) database, between the years 1999-2013. For my sample of other qualitative data on roadmapping practice, I selected two EC projects: NanoRoadMap (NRM) project, funded by the European Commission (FP6) and the

Nanofutures Integrated Research and Innovation Roadmap, also funded by the European Commission (FP7). These strategic reports contain different types of roadmaps varying by their focus on industry-sector, technology, product or administration. Facing their complexity and their different context of application, I offer an alternative approach to roadmaps and that is on the level of concepts, such as: strategy is a journey, purposes are destinations, means are routes, and achievements are landmarks. It is argued that 'metaphor' perspective provides means for improved understanding of roadmaps along the lines of its generic, dynamic and organizational capacities. Conversely, the „roadmap“ example supports the performative thesis of metaphor that does not just observe and explain a reality, but rather shapes, formats and performs reality. The technology roadmap is then a form of action and agency through which the future is both performed and colonised.

7.1. Understanding RRI

Chair: Kjetil Rommetveit

Responsible Innovation and Social Entrepreneurship: a Systematic Literature Review

Rob Lubberink, Wageningen University, Management Studies, The Netherlands
Vincent Blok, Wageningen University, Management Studies, The Netherlands
Johan van Ophem, Wageningen University, Economics of Consumers and Households, The Netherlands
Onno Omta, Wageningen University, Management Studies, The Netherlands

The European Union faces several grand challenges, i.e. complex problems involving people, planet and profit. In order to deal with such grand challenges, several transitions are necessary. Innovation is generally regarded as key to achieve transitions and to initiate change (Schumpeter 1934). Often innovation is mentioned jointly with entrepreneurship (Johnson 2001), since it is generally understood that entrepreneurs and entrepreneurial actors are needed to come up with, or deal with, innovations.
Profit-oriented business entrepreneurs, however, might not be the most suitable initiators for innovations that aim to deal with these grand challenges. This, because they focus predominantly on Profit and neglect the other P's: People and Planet (Blok & Lemmens, forthcoming). Social entrepreneurs, opposed to their profit-oriented counterparts, are able to prioritize people and/or planet without neglecting the economic viability of their company. They recognize social problems and create social value by solving the problems with their innovations (e.g. Mair & Martí (2006) and Schaltegger & Wagner (2011)), which is why social entrepreneurs can be seen as the 'transformational leaders' (Purdue (2001), or 'social transformers' (Pierre, Friedrichs & Wincent 2014), who aim to deal with the grand challenges.
However, it is still unclear how social entrepreneurial processes actually work, or how social entrepreneurs are able to make connections between aspects of social, business, and technological innovation (Pierre et al. 2014). The upcoming concept *responsible (research and) innovation* may help to understand this transformational leadership of social entrepreneurs. This, because in responsible innovation, the innovation process and its marketable product aim to be: ethically acceptable, sustainable and societally desirable (Schomberg 2013). Furthermore, we think that social entrepreneurs, already (implicitly) engage, to some extent, in responsible innovation.
Social entrepreneurship, like responsible innovation, aims to be initiated by, or at least to involve, citizens in their innovation processes. Moreover, social desirability, ethical acceptability, and sustainability of responsible innovations, are goals that are highly valued by social entrepreneurs as well (Boyett 1996). Furthermore, having multiple goals is a characteristic of both responsible innovation and social entrepreneurship (Pierre et al. 2014). However, responsible innovation is still in a phase of gaining conceptual weight (Stilgoe et al. 2013). Because most research regarding responsible innovation focuses on the theoretical concept and/or is research- oriented, it is still not known how the concept can be understood in a business context, and how it can be implemented in industrial business practices. That is why, in this paper, we will do a systematic literature review regarding industrial responsible

innovation processes that answers the following research question: *How can social entrepreneurial and industrial responsible innovation processes be understood?*
The systematic literature review will follow the same procedure as presented in the article by Seuring & Müller (2008). This means that we follow the process proposed by Mayring (2004). Briefly, this implies that first, the material collection is defined and delimitated. Secondly, formal aspects of the material are assessed in a descriptive analysis. Thirdly, structural dimensions and analytic categories are selected and applied on the collected material, and ultimately, the material will be evaluated according to the structural dimensions. This process should make sure that relevant issues are identified and results to be well interpreted.

Understandings of responsibility in the everyday practice of research and innovation

Susan Molyneux-Hodgson, *University of Sheffield, UK*

Resources continue to pour into the development of synthetic biology as a new field, in the UK as elsewhere. Roadmaps have been produced and a research and commercialisation trajectory laid out for the field to travel. Yet, progress with successful scientific practice and potential products seems to lag behind the policy and rhetoric of the fabulous futures synthetic biology will make. Understanding the mundane and everyday world of practice in synthetic biology therefore remains imperative, particularly as the sense of newness presented by the field leaves open greater possibilities for multiple actors to influence and shape the field towards a variety of ends. It is within this context of openness - the yet-to-be decided directions of everyday synthetic biology work - that we see a space for reflecting on notions of responsibility.
Even before the idea of responsible research and innovation became a normalised policy imperative in UK funding regimes, synthetic biology had incorporated social scientists into its fold and in a range of guises. Thus the author was recruited into a scientific research endeavour with a remit to assess the 'social feasibility' of a synthetic biology project, alongside others conducted assessments of the 'technical feasibility' of the work. This paper gives an analysis of that funded synthetic biology project, that involved bringing together different kinds of academic and industrial engineers, alongside sociologists, to address water industry challenges. Ethnographic work over 18months and across a range of field-sites, aimed to address how synthetic biology came to be seen as the solution to water problems by the participating groups and what implications flowed from this. What became central to the analysis was the way in which the differing engineering communities involved in the project, mobilised microbes and social scientists as playing a role in the synthetic biology world.
The paper takes a particular slice through the overall analysis to report on the experiences of sociologists working alongside scientists and engineers and specifically on how notions of responsibility played out across people and things.

Responsible biopatenting practices

Anders Braarud Hanssen, *Oslo and Akershus University College, Norway*
Ellen-Marie Forsberg, *Oslo and Akershus University College, Norway*

In a world where research and trade are global, and emerging technologies create new challenges for responsible governance, the question of how ethical and social concerns should be taken into account in technology management is more relevant than ever. Initiatives are now taken to develop a framework for Responsible Research and Innovation (RRI) to be applicable for all development of new science and technologies (Owen and Goldberg 2010,

von Schomberg 2012)'. Such initiatives have primarily been directed at making researchers reflect upon the social and ethical consequences of their research (Fisher, Rip 2013), and on developing science and innovation strategies that are responsive to societal concerns, often by means of stakeholder engagement or public deliberation. The role of other institutional actors in the innovation system, such as patent offices, has been subject to less discussion, notwithstanding their importance for the embedding of science and innovation in society. Increasingly researchers are encouraged, both by policy makers and research institutions to consider intellectual property rights aspects of their work. The intention is more commercialisation of research, in order to increase economic growth and prosperity. However, in the case of biotechnology, patenting inventions may also have adverse effects on innovation and production of societal goods, in addition to the many instances of controversies related to patents on biological material. The work presented here takes its starting point in the conviction that also this part of the innovation system needs to be responsive to societal expectations of responsibility, and the project will assess the current patent regime in light of current models for RRI.

This paper will present an analysis of some of the most important ethical issues related to current biopatent practices in Europe. It will discuss what room the 'ethics paragraph' in international patent law, providing protection of '*ordre public* or morality' (TRIPS, Article 27.2 Patentable Subject Matter), gives for addressing ethical concerns. It will also address ethical aspects of patentability judgements. A number of daily decisions and judgements in patent law practices have moral implications: seeming technical decisions may involve distinct normative dimensions not often clearly articulated in a transparent and open process. We will argue that in cases where there is ambiguity, doubt or uncertainty related to impacts of the technology or process described in a particular patent application, judgements will be made by patent officers where (from an RRI point of view) ethical implications of granting the patent should be considered. This paper will exemplify this with reference to findings from on-going case-studies.

7.2. Computer Guidance and Decision Making for Safe and Sustainable Nanomaterials

Chair: Ineke Malsch

Introduction to the proposed methodology

Ineke Malsch, *Malsch TechnoValuation, Utrecht, The Netherlands*

The starting point of the SUN methodology is mental modelling theory. This is a psychological theory according to which individuals observe and act in the world based on more or less correct "mental models" they have formed of reality. For our objectives, a mental modelling approach appears most suitable (Wood, Bostrom, Bridges and Linkov, 2012). Insights from the distributed cognition methodology (Hollan et al, 2000, Hutchins, 1995, Nersessian et al, 2003) may further guide how these user mental models can be combined into a software tool that can potentially facilitate a shared understanding of safe sustainable nanomanufacturing among these user communities.
Our user elicitation methodology can be visualized as a funnel, which starts with broader questions in the early phase of the project and narrowing down to quantitative criteria scoring and evaluation at the later stages. We use telephone interviews and a user workshop. Semi-structured questions are used to understand user perspectives on sustainable nanomanufacturing and broad tool capabilities. At a more advanced stage, the users are also asked to rate criteria developed in the conceptual model to run a Multi Criteria Decision Analysis (MCDA) model for case studies in the use of DSS for sustainable nanomanufacturing.

State-of-art SUN DSS Conceptual Framework

Elena Semenzin, *Ca' Foscari University of Venice, Italy*
Danail Hristozov, *Ca' Foscari University of Venice, Italy*
Vrishali Subramanian, *Ca' Foscari University of Venice, Italy*
Antonio Marcomini, *Ca' Foscari University of Venice, Italy*

There has been an explosion of information related to nanomaterials toxicity and risk; however variations in the material composition, their complex chemistry and their environmental fate make industrial and regulatory decisions difficult. The uncertainty related to hazard, exposure and risks associated with nanomaterials is high; and evidence often points decision makers in opposite directions. Currently, integration of scientific data is based on intuition, opinion or over-simplification. Decision analytic frameworks and Decision Support Systems are capable of addressing heterogeneous information and uncertainty, and also facilitate the incorporation of user values into decision-making.
This talk presents the ongoing development of conceptual framework of a DSS for sustainable nanomanufacturing. We describe how the MCDA framework enables the systematic aggregation of manufacturing, risk assessment, risk management criteria, and how such an aggregation may promote sustainable nanomanufacturing. We seek audience feedback on the MCDA framework criteria, as well as other capabilities and features of the DSS user interface.

Ethical decision making in the presence of uncertainty: Rawls as an alternative to Utilitarianism in Nanoethics.

Martin Mullins, *University of Limerick, Ireland*
Karena Hester, *University of Limerick, Ireland*
Finbarr Murphy, *University of Limerick, Ireland*
Tofail Syed, *University of Limerick, Ireland*

The development of nanotechnology (NT) in the context of a globalised economy represents a serious challenge to global policy making in general and the regulatory community in particular. While current policy theoretically embraces the social and ethical aspects of the development of nanotechnology, the regulatory framework which is applicable to NT is narrowly focused on safety values with justification for any risk based on economic and internal market drivers. We argue that the precautionary principle is not a suitable instrument for application to NT, that social and ethical issues where they are incorporated in the existing regulatory framework will have little impact and that social and ethical issues are seen as a threat to the commercial and economic future of NT. Moreover, consequentialist or strictly utilitarian model is problematic given the degree of uncertainty among scientists. The goal of this paper is to suggest ways forward for ethicists operating in this field, in particular to address the issue of ethical decision making in the presence of high degrees or uncertainty. We argue that applied ethics should underpin the decision making process We posit an ethical protocol based upon principles of public international law which situates the debate on the ethics of NT in a space which is not reliant on either scientific certainty of highly normative principles. An approach which attempts to address the issues of responsible innovation, value-sensitive inclusiveness and collective responsibility for risk in terms of distributive justice may indeed offer a way forward in a addressing the SEI issues inherent in NT activity. This paper will examine the issue of Nanoethics through the prism of Rawlsian theory. In the adoption of new technologies, risk and the distribution of risk, distributional equity, social justice and community impact are central components in terms of sustainability. Without such an approach NT activity may become vulnerable to changes in public perception/opinion which will affect the ethical and social acceptability of NT and, in the long term, have a negative impact on the sustainability and social desirability of this technology.

7.3. Science and Decision Facing Emerging technologies: Uncertainty, Non-Knowledge and (Self-)Commitment

Chairs: Christian Büscher/Jutta Jahnel

Risk Calculation as Experience and Action: The Interaction of Risk Assessment and Management as Mechanism for the Absorbtion of Uncertainty

Christian Büscher, *Karlsruhe Institute of Technology, Germany*

In this presentation I will discuss the function of scientific risk calculations in organized risk management. With scientific risk calculation I refer to the relation of the analytical distinct notions of data, information and knowledge. Scientific risk calculation relates knowledge (theories, methods), data (results of experiments) and information (validating or rejecting hypothesis) in a way that it leads to probabilistic statements, which have to be communicated in meaningful terms. My argument is, for action, e.g. decision making, the relation is different, as the multitude of expert statements has to be taken as data, the selected expertise as information and social practices, norms, routines as confirmed knowledge. Such a model underlines the selectivity of the scientific knowledge production and the decision-making process. It rejects the general idea that scientific knowledge is just passed on to those persons/ organizations in need, or is *per se* a base for decision-making.
In general, we have to presume that the correlation between science and decision is not of a deterministic kind. The communication of scientific findings does not lead to action unmediated. Accepting scientific statements on risk and hazard as premise for political, legal or economic action is first and foremost improbable. The primary objective is, to frame this problem, and to draw attention to the need to understand the social mechanisms allowing for the mutual absorbing uncertainty in the interaction of *science* and *decision*.
In this sense, this discussion attempts to consider explicitly the autonomy of social systems and their way of processing novel, hypothetical knowledge, which science is now establishing in regard to the highly complex issue of *nanomaterials*. The main argument is, if knowledge alone does not function as a mechanism for absorbing uncertainty any more, than the interaction of science (risk assessment) and decision (risk management) must fulfill that need, in order to allow decision-making as temporarily stable *self-binding* in an inclusive and iterative manner.

Conceptual questions and challenges revealing the traditional paradigm for assessing nanomaterials

Jutta Jahnel, *Karlsruhe Institute of Technology, Germany*

While there is rapid growth in the commercial applications of nanomaterials and nanoproducts the potential safety issues have to be addressed carefully. Scientists are requested to assess possible environmental, health, and safety (EHS) risks, and to provide policy makers with the appropriate knowledge for an evidence-based risk management. The conventional chemical risk assessment procedure is an expert-based chemical-by-chemical

approach, which provides a range of data with its inherent variability and uncertainty for the prediction of possible harmful effects. Despite serious methodological uncertainties, the risk assessment approach is based on confidence in the relevant knowledge and on the possibility to assess and manage uncertainty. In addition, the traditional model is based on a conceptual distinction between risk assessment and risk management. While risk assessment is viewed as a scientific endeavor, the decisions of risk management are determined by normative, cost, and other non-risk factors. However, in the case of nanomaterials there is an increasing disconnect between the scientific knowledge production and the information needs of decision makers, despite the growing output of scientific toxicological research.
As a consequence, EU and US scientific committees proposed to reconcile the previous dichotomy of the different domains of "science and decisions". The results of the scientific studies should rather be expressed in terms of its value-relevant impact on humans and ecosystems than "in terms of technical surrogates". In addition, risk managers should be involved in the risk assessment process without distorting its scientific objectivity. The input and participation of risk managers is needed both in preparing an assessment procedure and throughout the whole process. Advantages of this integration would be an increased likelihood that the scientific findings will better agree with the final risk management option. The presentation will elucidate this approach with different examples of alternative frameworks for the risk governance of nanomaterials.

Logic of Decision or Logic of Care? Uncertainty, Technological Mediation and Governance

Christopher Groves, *School of Social Sciences, Cardiff University, UK*

How to make sense of an uncertain future, and how to extend bridgeheads of certainty from the present into it are universal human concerns, founded on the precariousness of human existence (Adam & Groves, 2007). Risk thinking (Rose, 1999) represents one particular understanding of how to perform these linked tasks, in which scientific data about potential future states of some naturalistic system feeds back into present decisions that adjust the functioning of the system so as to avoid triggering adverse outcomes and, in worst cases, uncontrollable harmful processes. Risk thinking views the process of moving from data to action through a metaphor of governance that co-evolved with industrial machinery (Lösch, Gammel, & Nordmann, 2009). This implicit model of risk-based decision making is problematic, however, insofar as the feedback loop around which it is based is rooted in the past of the settled scientific corpus. Yet the deployment of new technologies is of concern precisely because of the possibility of 'surprises', events that are not present in the probability distributions given to us from past observation and experience. Yet it is the capacity for such surprises that is, ethically speaking, the most problematic feature of how technologies mediate our relationship with an uncertain future (Grinbaum & Groves, 2013; Jonas, 1984). The irreducible complexity of the interplay of social action, technological artefacts and natural phenomena makes how to live with the prospect of unexpected novelty, and with persistent ignorance and nescience, central problems for technological societies. To solve this problem, we cannot rely on treating the entanglement of technologies, societies and non-human nature as reducible to a self-enclosed system, with governance appended to it as an external regulator. Instead, governance has to be shaped by how technology mediates relations between the present and the future of entangled social and natural phenomena. Technologies are shaped by social priorities, conceptions of needs which must be provided for. They also serve to change our conceptions of what are worthwhile ends of action. By conceiving of the relationship between technology, society and nature as a form of mediation that exhibits a

logic of ongoing, future-oriented care rather than one oriented towards framing and processing punctual decisions (Mol, 2008), it may be possible to reconfigure governance as an effective 'mediator' of future-oriented care rather than an external 'governor' of innovation mechanisms.

DPSIR- and Stakeholder Analysis of the Use of Nanosilver

Steffen Foss Hansen, *Technical University of Denmark, Denmark*
Maja K. Lindbladh, *Technical University of Denmark, Denmark*
Katrine B. Schiolborg, *Technical University of Denmark, Denmark*
Mikkel Foltmar, *Technical University of Denmark, Denmark*

The use of nanosilver has increased dramatically in recent years and about 20 % of all proclaimed nanoproducts now contain nanosilver (see www.nanodb.dk). First concerns about the use of nanosilver were raised almost a decade ago, but assessing the risks has been extremely challenging scientifically and regulation to protect the environmental and human health remains controversial. In order to understand and map the known risks and issues associated with the use of nanosilver, we did a DPSIR-analysis and analyzed the Drivers, Pressures, State, Impacts and potential policy Responses. We found that most concerns relate to the potential contribution that nanosilver might have to the development of multi-resistant bacteria and the environmental impacts of nanosilver. In order to qualify the identified potential policy responses, we did a stakeholder analysis in order to explore possibilities for reaching consensus among stakeholders in regard to regulation of nanosilver. Besides European and national authorities, consumer and environmental NGOs and industry were identified as being vital to include in the decision-making process due to their different interests, influence and power when it comes to regulation of nanosilver. Especially, SMOs need special attention as they seem to have a lot of interest, but little influence and power compared to the more established industrial entities. From the DPSIR-analysis, we found that a new legislation for nanomaterials in general and nanosilver specific changes in the current European chemical, biocide and medical legislation were the optimal policy responses along with limiting the overall use of nanosilver. Through the stakeholder analysis, these policy options were however not deemed to be implementable, as industry and NGOs seems to have fundamentally conflicting views and interests that fundamentally comes down to different ethical perspective on nature and the environment and whether or not the environment and ecosystems have a "carrying capacity" when it comes to the use of nanosilver.